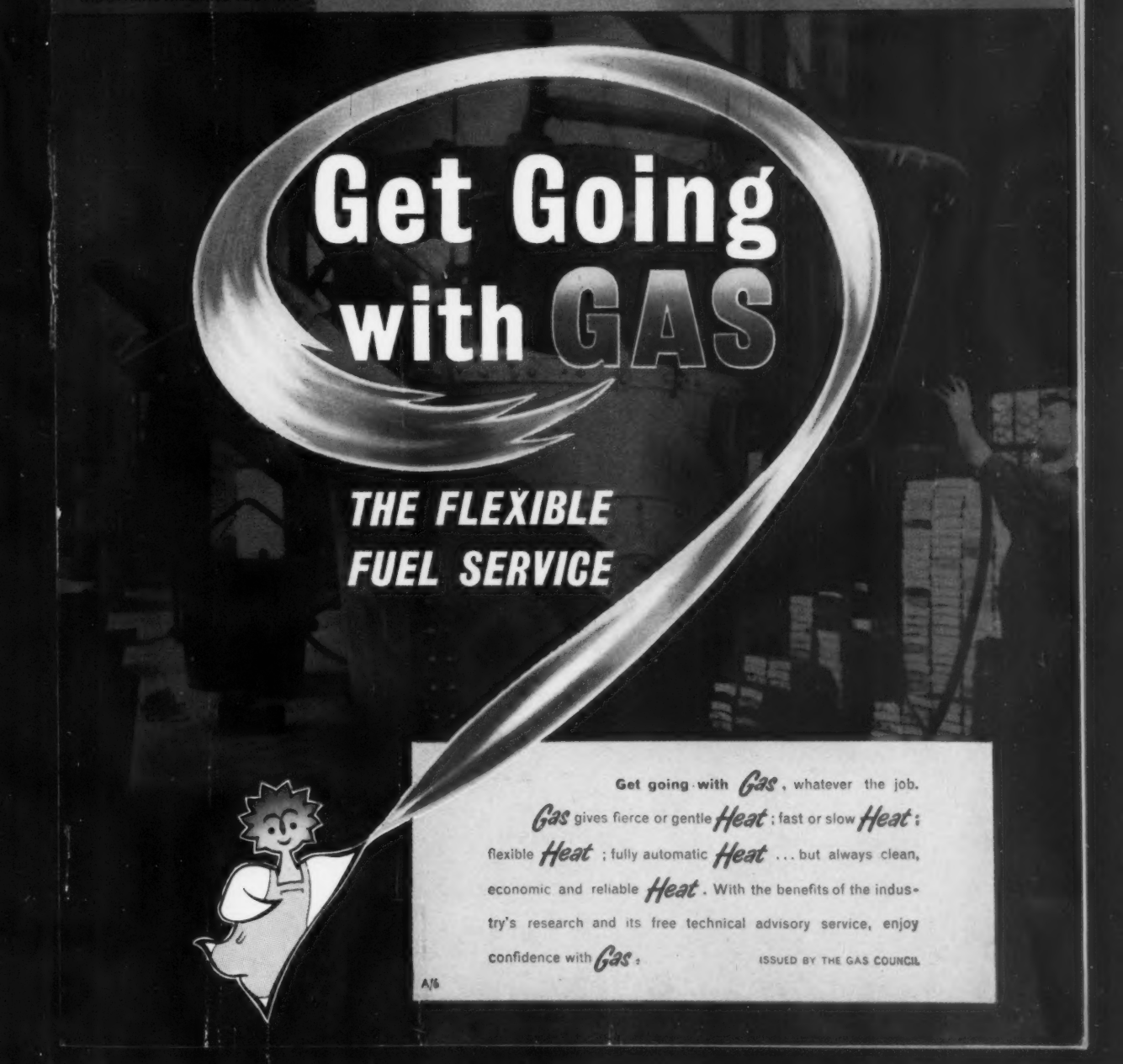
metal finishing

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 7 No. 82 (New Series) OCTOBER, 1961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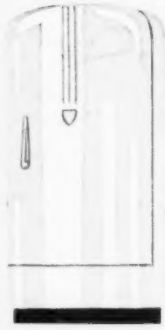

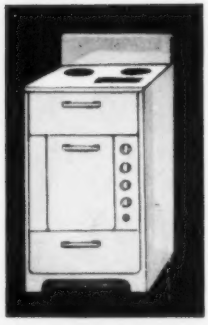

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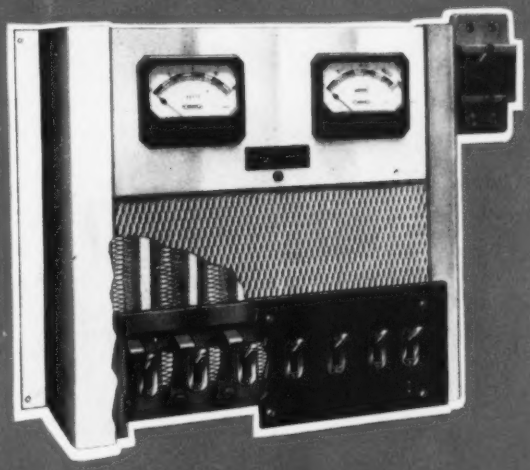

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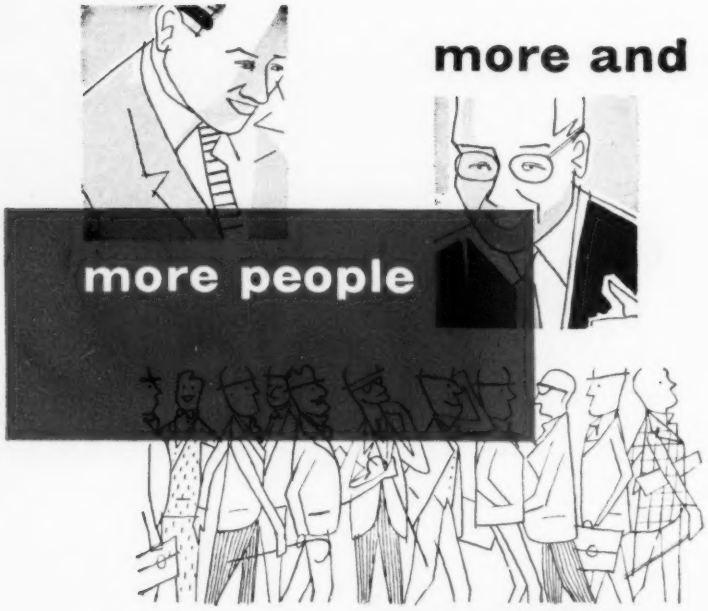

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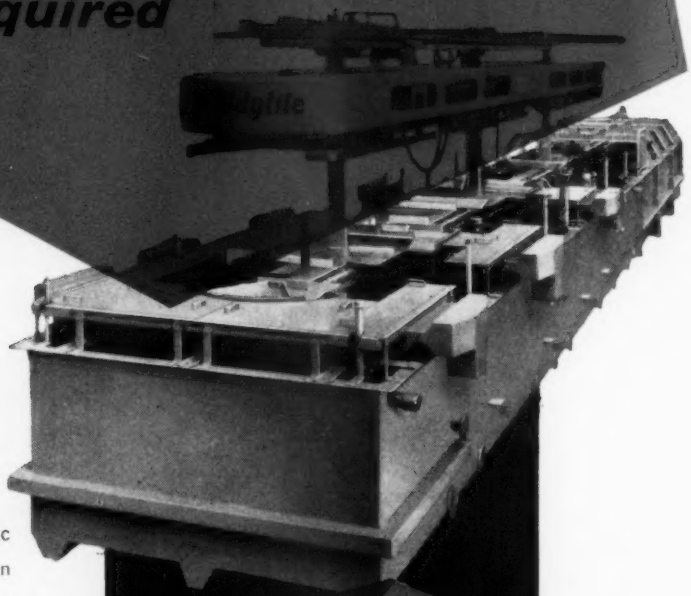

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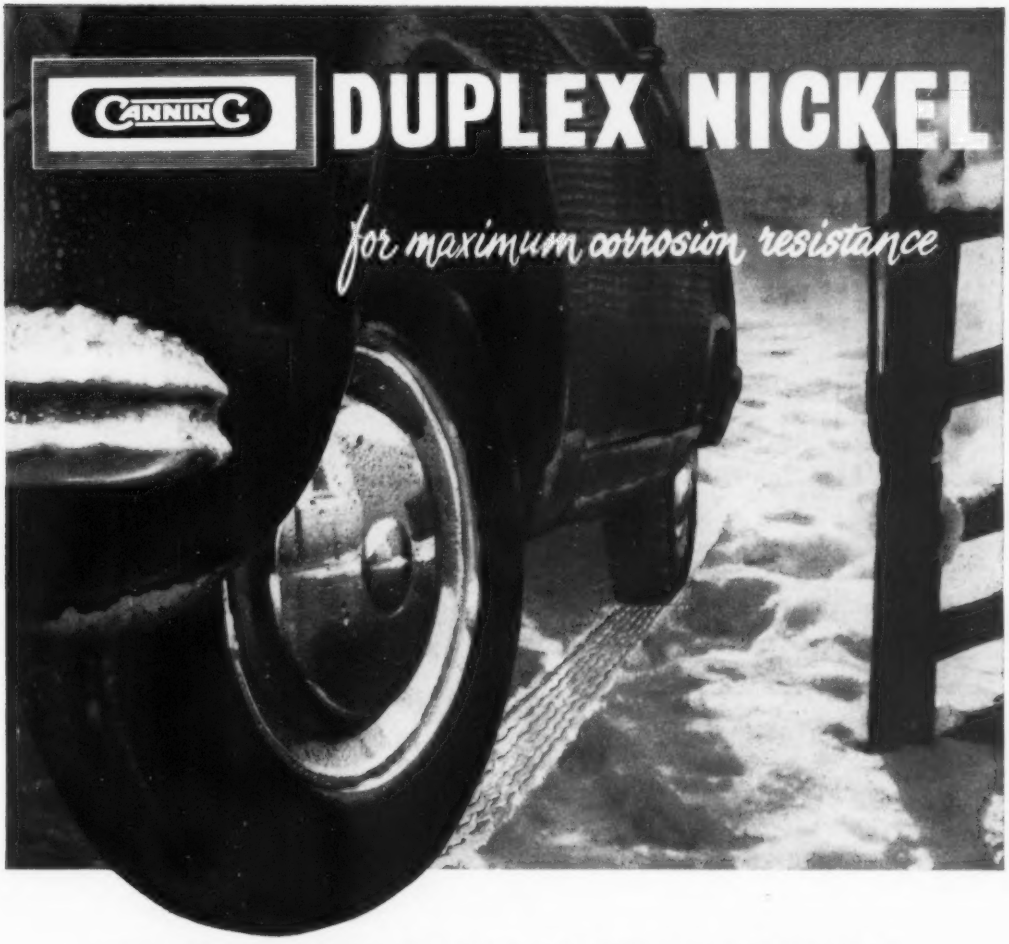

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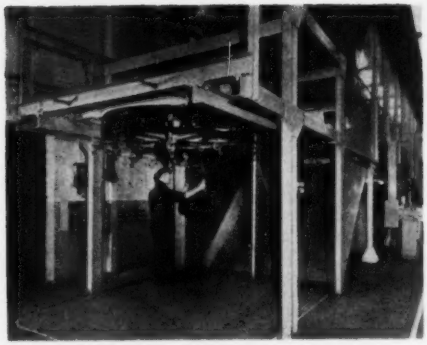

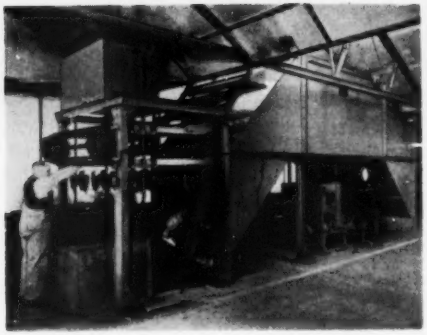

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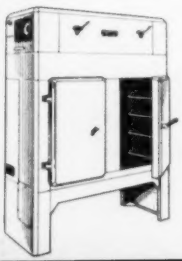

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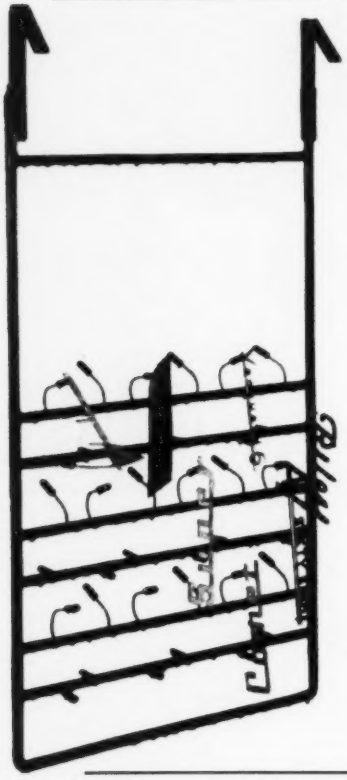

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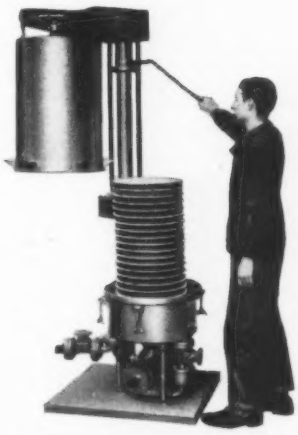

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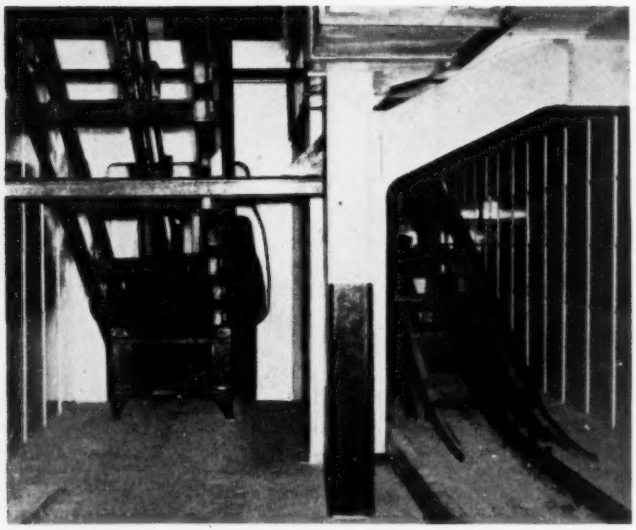

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metal finishing journal

October, 1961 — AN INDUSTRIAL NEWSPAPERS PUBLICATION — Vol. 7, No. 82 (New Series)

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Home and Overseas 24*s.* per annum prepayable
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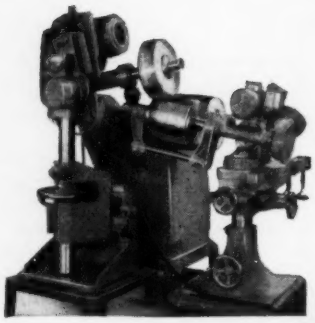

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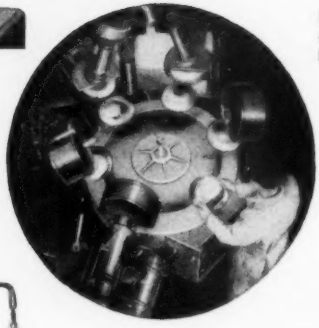

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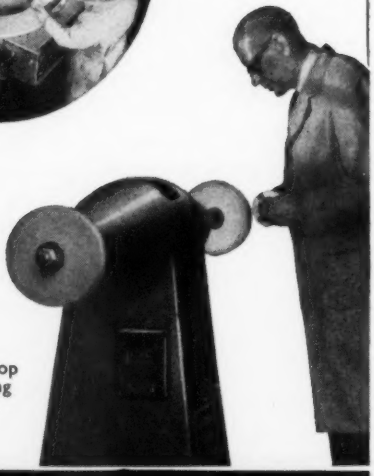

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A COMMENT made by an exhibitor at the Industrial Finishes Exhibition held in London earlier this year was to the effect that there was a healthy and growing tendency by the majority of manufacturers to consider finishing processes as an integral part of a production sequence. No longer was it usual to specify a finish as just "slapping on a coat of something"; a finish, whatever its type, whether essentially protective and/or decorative, must be considered seriously in the light of a component's subsequent use and environment. This continuing realization of the importance of "finishing" in the light of modern needs was again confirmed at the recent International Galvanizing Conference held at Interlaken, a report of which begins elsewhere in this Journal. Not only was this conference, the sixth in the series, the largest to date, but it showed without doubt the great current interest in the theory and practice of galvanizing, papers on both aspects being presented.

Reviewing the conference there were some features of the galvanizing process which were obviously being given a great deal of attention. As might be expected, the question of mechanization was discussed. It was pointed out that since 1938 the output of steel in the U.K. has almost doubled, whereas the increase in output of the general galvanizers represents but a small proportion of this greatly increased tonnage of steel, and in a "high operator wage industry" such as general galvanizing, mechanization should be given serious thought. Although the importance of mechanization to the industry has been established, one difficulty facing it is the wide variety of shapes and sizes of components that have to be processed. Reports of American practice, however, seem to indicate that this difficulty can be overcome.

Of major significance were the papers on structural steel. Future progress in this field is likely to be considerable and undoubtedly form a growing outlet for hot-dip galvanizing, particularly as it appears that the weldability of galvanized structures is good, provided that the correct electrode is chosen and the rates of travel are not too high, and the mechanical properties of welded joints are practically the same as on ungalvanized steel.

Great interest was also expressed on the paper referring to thick galvanized coatings; it appears that these can be obtained on ordinary steels as distinct from silicon steels by preparation of the surface by shot-blasting. A further advantage is that on ordinary steels the coatings resemble normal galvanized coatings in structure having the usual outer layer of unalloyed zinc. A thicker coating could be of inestimable value on outdoor structures where maintenance is a problem or where a final paint coating is impracticable.

Although there was only one paper dealing with steel sheet this was important as it emphasized the value of precoated sheet to the automobile industry. It was obvious also that the emphasis on sheet galvanizing has swung away from corrugated materials to flat products.

Taken as a whole the conference was impressive from the point of view that it showed that the industry is fully alive to the needs of the present and the future. International research and development is continuing apace and further and increasing dissemination of information on the advantages of galvanizing is to be effected. We are continually being told of the high cost of corrosion to this country, and indeed to the world; in the elimination of a significant proportion of this cost zinc coatings, properly used, can play an increasingly important part.

Talking Points

by " PLATELAYER "

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

NEWS FROM GERMANY

IT is not easy to obtain statistical information relating to the electroplating industry in the United Kingdom ; in Germany, however, the existence of an efficient trade association enables a good deal of useful data to be disseminated. This is a very valuable factor in building up an export trade, since it enables the industry to determine where its markets are likely to develop.

Among the interesting details disclosed in the latest survey is the fact that Britain last year was Germany's largest export market for plating plant. The value of plant imported here was over £100,000, a five-fold increase over the previous year (due in the main to a single contract). Before this, progress had been rather slow. Holland and France followed closely behind, again with very sharp increases over 1959. Total exports to Europe have more than doubled over the last five years, and for the rest of the world they increased by fifty per cent.

So far as plating chemicals and products other than plant are concerned, the largest market by far was, surprisingly, the Soviet Union, which imported materials to the value of some £175,000 from West Germany, but no plant at all. France and Gt. Britain again came next with £32,000 and £23,000 respectively.

German industry is spending a good deal on research and development in the electroplating field, and this is no doubt an important factor in the progress which is being made.

EXTRA-TERRITORIAL RESEARCH

AS it is the common fashion nowadays to deplore the small amount of money this country spends on research, it is some consolation to learn that, according to the Advisory Council on Scientific Policy, 2.35 per cent of the gross national product was spent on research, a figure not vastly less than the corresponding one of 2.74 per cent for the U.S.A. Half of this was on account of private industry (£240 million).

Whether all this money was deployed in the most useful way from a national point of view is another matter, and there is no doubt that some important industries spend extremely little. The machine-tool industry, in particular, has been the subject of particularly strong official criticism lately. The metal-finishing industries also spend relatively little on research. Nevertheless, both these industries have strong ties with the U.S.A. in the form of license agreements to manufacture American products. This means that, in effect, they are supporting the research activities of their associates to a very substantial degree ; the results undoubtedly benefit this country, and enable us to produce up-to-date goods both for the home and the export markets.

Although royalties and similar payments do not appear in the statistics as research expenditure, they should nevertheless rank as such to a substantial degree, even if the work is done extra-territorially, as it were,—often by emigrant British scientists.

QUALITY COUNTS

BY a remarkable coincidence, shortly after my comments in the August issue to the effect that no sympathy need be wasted on platers who complain that they are unable to produce good plating because their customers will not pay for it, a letter was published in the BSI News for the same month from Mr. Frank A. Parker, Sales Director of V. C. Saunders Ltd., whose experience strongly supports this point of view.

The company, which produces a range of chromium plated motor-car accessories, found that when they joined the Mond labelling scheme, their plating costs were increased to such an extent that they were obliged to increase their selling price to enable them to meet the B.S.I. specifications. When the reason for this was explained to their customers, there was not one single adverse reaction to the change, and many of them expressed the view that it was a step in the right direction.

MISNOMER (Continued)

There is nothing like vitreous enamel for hot water !

I HAVE been taken to task by the Vitreous Enamel Development Council and others for my remarks last month that the recent prosecution of a paint-manufacturing company for using the term " porcelain enamel " to describe one of their products " failed." I should have made it clear that the " failure " was to confirm that the company had deliberately set out to defraud. They were, of course, as the report in the August issue of this Journal clearly pointed out, guilty of an offence under the Merchandise Marks Acts and were fined accordingly.

6TH INTERNATIONAL CONFERENCE ON HOT-DIP GALVANIZING

INTERLAKEN JUNE 5-9, 1961

THE sixth International Conference on Hot-Dip Galvanizing was held this year in Switzerland from June 5 to 9, and was organized by the Zinc Development Association and the Swiss General Galvanizers' Association on behalf of the European General Galvanizers' Association. The technical sessions were held at Interlaken, once the location of an Augustine monastery in 1133 and now the centre of the Swiss tourist trade and internationally known to conferences for its scenery and climate and the exceptionally fine hotel facilities.

The conference was attended by a record number of some four hundred delegates from twenty countries who with their ladies attended a reception given by the Swiss General Galvanizers' Association on Sunday, June 4 at the Grand Hotel Victoria Jungfrau, where they were welcomed by Mr. A. Pezolt, Secretary of the Association and Mr. Max Brodbeck, President of the E.G.G.A.

The conference was formerly opened at the Kursaal on the morning of Monday, June 5 by Mr. Max Brodbeck and Mr. R. Gloor, President of the Swiss Galvanizers' Association, int he presence of the Burgomaster of Interlaken. After welcoming the delegates, Mr. Brodbeck observed that it was three years, as opposed to the normal two, since they had last met. He added that the reason he was standing before the conference as President was due to the sudden death of the first president of the E.G.G.A., Professor Heinz Bablik. He regretted that it would not be possible for him in the time at his disposal, to go into the life and work of Dr. Bablik, but he was pleased to announce that at the Annual General meeting of the E.G.G.A., on the suggestion of Mr. van Eijnsbergen of Holland, it had been decided to publish all the outstanding or remaining writings of Dr. Bablik in one complete work, in memory of the man who had been both an inspiration and a kind personal friend to all in the galvanizing industry and whose Viennese charm and humour would be greatly missed.

A minutes' silence was then observed in honour

Mr. R. Gloor, President of the Swiss General Galvanizers' Association, addressing the opening meeting of the Conference.

of Dr. Bablik and all who had passed away since 1950.

He went on to welcome Mr. Borter, President of the Municipal Council of Interlaken as a guest, and assured him that they had looked forward to holding the Sixth Conference in the world famous resort, where for four days they could turn their backs on industrial life.

He drew the attention of the delegates to the photographic exhibition as well as to the display of manufactured goods and also to the fact that they would be holding for the first time informal discussion groups at which such subjects as labour, welfare, costing and financial management would be covered.

Mr. R. Lewis Stubbs, Director of the Zinc Development Association, dealing with the organization of the conference, said that much of the detailed work had been done in London by the Secretariat, and they owed a great deal to Mr. Morgan Davis and his colleagues. He referred also to the fact that for the first time copies of all the papers were available in French, German and Italian before the conference.

Mr. Robert Gloor said that as the President of the Swiss General Galvanizers' Association he had been requested to undertake the preparatory work for the Conference, a considerable task for a small association. He went on to say that it was the hope of the organizers that all those attending the conference would take an active part in the discussions and that they would feel free to criticize whenever they cared to do so.

He thanked all the guests for attending and stressed the fact that integration throughout the world was proceeding at a very rapid pace and every possible contribution would be needed to serve mankind adequately. In their own Association as well as in Galvanizing Associations throughout the world it would be necessary to have closer integration of the various special groups. As Europeans they had tremendous responsibilities. He said that the present age was one of atomic power, which was playing an ever increasing role, but he wished to remind all that it was first the plough and then the faculty of communication that had enabled man to take a tremendous step forward. It was hoped that mankind would soon be able to take similar steps.

The Conference now formally open, the following week saw the presentation of twenty-six papers at nine technical sessions. Wednesday and Thursday were devoted to visits to works in Switzerland and Italy.

An interesting programme had also been arranged for the ladies and the Conference ended on Friday, June 9, with a banquet at the Grand Hotel Victoria Jungfrau by invitation of the Swiss General Galvanizers' Association.

Abstracts of the papers presented at the first two sessions are published below together with an edited report of the discussion following their presentation.

Session 1a

Chairman : Mr. Max Brodbeck
(Verzinkerei Pratteln A.G.)

Survey of Practice and Applications of Galvanized Steel

E. C. Green and M. H. Davies
(Zinc Development Association)

THIS paper presents performance data on the working of galvanizing baths based on returns for a work period of three months made by thirty-seven firms, eighteen in Germany, eleven in Great Britain, and five in other European countries. The authors point out that owing to the relatively small size of the sample the data may not be representative of the full range found in the galvanizing industry. The information is presented in a substantial series of tables for a study of which reference should be made to the full text of the paper.

The authors comment particularly on the very wide scatter apparent in some of the figures quoted. For example, the wide range in heating efficiencies and in heating costs per ton, even for plants processing similar work suggests that there is considerable room for improvement. The data for the wire galvanizing plants, which could operate under rather better conditions than the jobbing plants also show a surprising range in heating costs.

Similarly there is a very wide range in the individual results quoted for the zinc losses arising from dross production and some of the figures defy explanation when compared with others for the same type of work.

A further general improvement in zinc efficiency is apparent in comparison with results obtained in two previous surveys, and in particular most German plants now show combined losses of ash and dross of less than one third of the zinc used, while most British plants report combined losses of between one third and one half of the zinc used.

Figures for acid and flux consumption reveal quite large differences between plants processing similar materials, although in general mechanized plants with their improved control use less of these materials, particularly flux.

There is a general increase in throughput with increase in size of bath but the figures show that some baths are very much more productive than others of the same size where similar types of work are involved.

The authors conclude by pointing out that the vagaries of the galvanizing process of such that different baths are operated by the same company at widely differing efficiencies, and this is presumably due to the limitations imposed by the nature of the work.

DISCUSSION

Mr. C. Origoni (Origoni & C. Metalli), said that the data concerning the waste of zinc, or zinc losses in dross, shown in Table V, where comparisons were made between the old dry process, the dry process and the wet process, and for steel sections and structural sections it was better to have the dry process, whereas for tubes and tanks, cylinders and cisterns, the two processes had the same figures in losses of zinc. For holloware, window

Mr. Borter, President of the Municipal Council of Interlaken, presenting the Golden Key of Interlaken to Mr. R. Gloor. Mr. Max Brodbeck, President of the E.G.G.A., is behind Mr. Borter.

structures and nuts and bolts etc., the wet process had the advantage.

His own plant was small, like those in most countries. There were three baths for a total content of 225 tons of zinc and galvanizing was done by the wet process. The production for three months was 3,750 tons, divided up (using Mr. Davies' method) as follows : structural sections and assemblies, 45 per cent ; average and heavy tubes, tubes for gas etc., 29 per cent ; light tubes for irrigation, 9 per cent : tanks, cylinders and cisterns, 9 per cent ; sheet iron, 5 per cent ; various others, 3 per cent.

The figures of consumption were : zinc put into the bath, 9.58 per cent ; hydrochloric acid, 3.78 per cent ; ammonium chloride, 0.75 per cent ; aluminium 0.065 per cent ; *i.e.*, 65 gm. for every 100 kg of zinc. The consumption of natural gas was 7.75 per cent. The product was the following : dross, 20.75 per cent, ash 12.27 per cent, burnt salts, 14.34 per cent. The dross was given in transformation to specialized forms. The total zinc was 5.78 per cent and the recuperated zinc 1.76 per cent. In conclusion, of 100 kg. of zinc put into the bath 21.15 kg. were lost.

Mr. Ch. van Kempen (Johan Vis & Co., N.V.) said that he would appreciate some more information about Bath No. 32. This bath contained 2 tons of zinc and was producing 0.6 tons of work as an average. As this bath was galvanizing bolts and nuts the basket weight brought the average through-put to about 0.8 tons of steel. The dipping of 0.8 tons of steel in a bath in just over 10 cu. ft. could only be done, according to his experience, in a zinc temperature of well over 500°C. In that case he would guess that the zinc kettle was a graphite crucible. He was very much interested in these production figures, and more or less the same question applied to Bath No. 31, dealing with sheet work, and to Bath No. 30.

Mr. K. Lewus (Gemeinschaftsausschuss Verzinken), said that the information was based on the German galvanizing industry. On his return to Germany he would contact the firm concerned and make the information available.

German industry had found increasing demands made on their galvanizing plants, particularly with reference to steel construction. They were successful in particular in the German railways, which expanded their electrification and became excellent customers. The German galvanizing industry was now endeavouring to create the necessary capacity so as to serve the German railways effectively, because they felt that this would be an excellent example to the world as a whole. In addition, he regretted, when reading the report, that the figures for fuel consumption in the German industry were not quoted, because of an oversight. German ovens were modern and had a relatively low consumption of fuel. In the case of modern heating plant it was something like 30 kg. of oil per ton of produce, and this referred to the two- or three-shift type of establishment.

Oil heating was being increasingly used in Germany, and Mr. Davies and Mr. Green were justified in stating that oil was the decisive factor in modern heating installations. Perhaps it had not been sufficiently expressed that gas heating

was not on the increase. They had to have a very low price for gas in Germany to be able to compete with oil, the price of which normally was 30 per cent below that of gas. Generally speaking he also wished to point out that, as regards the cost of heating and the cost of flux consumption, the engineer was sufficiently idealistic to present the best possible figures, but these figures were not really an essential element. If they could save 20 per cent of the fuel cost the total cost of production would only be affected by 0.5 per cent ; the saving would not exceed that figure.

With regard to ash and dross, his experience in Germany was that a well-managed undertaking should not have more than 30 per cent total dross and ash. Depending on the wet or dry process there might be a slight variation in these figures.

AUTHORS' REPLY

MR. M. H. DAVIES, in reply said it would be appreciated that there was a great deal of difficulty in gathering the information and it had been anticipated that there would be much critical comment.

One thing in Mr. Origoni's remarks needed a little clarification. He was a braver man than he would have been himself in making a classification of the superiority of one or other process for different kinds of work. It was not his view that the figures justified this. One must remember, for example, particularly in looking at the wet galvanizing process, that the flux skimming figures were not given there. There might be some balancing error which must be taken into account which would adjust the relative efficiency in one or other of these processes.

Session 1b

Chairman : MR. G. PIPER
(Nordic Circle of Hot Dip Galvanizers)

A Note of the Production of Thick Galvanized Coatings

E. C. MANTLE
(B.N.F.M.R.A.)

THIS paper briefly records work carried out by the British Non-Ferrous Metals Research Association in collaboration with the Hot Dip Galvanizers' Association to determine what practical measures are required to produce thick coatings and to estimate the controllable limits in dipping procedure required to yield consistent coatings within a given thickness range.

Preliminary trials indicated that it would be difficult to guarantee by the usual production methods an average coating weight of, for example, 3 oz. per sq. ft. on the smaller sections of structural steel, although it would doubtless be produced regularly on larger steel sections. In an experiment with double dipping two separate immersions of two-minutes' duration each gave contrary to what has sometimes been suggested, no thicker coating than a single immersion of four-minutes' duration.

Three possibilities of effecting an increase in coating thickness were considered, *viz* :

1. The bath temperature can be increased above 480 deg. C. to increase the rate of attack of the zinc on the steel. The enhanced attack of the zinc on the galvanizing pot itself constitutes a substantial disadvantage to this approach.
2. The rate of attack of the zinc can be increased by variations in composition of the steel being galvanized, a pronounced effect being produced by an increase in the content of silicon. The disadvantage here is that in the U.K. silicon bearing steels command a considerably higher price.
3. Measures can be taken to entrap more liquid zinc while the work is being withdrawn from the bath, an effective way of doing this being by increasing the surface roughness of the steel.

Experiments with shot-blasting indicated that roughening the steel surface by a suitable grade of abrasive provided an acceptable alternative to the use of an alloyed steel high in silicon where thicker than normal galvanized coatings were required. Some evidence was obtained that control of the thickness might be possible by varying the type of abrasive used, but this has yet to be confirmed by industrial trials. The coatings had some advantage over those produced on silicon-containing steels in that they resembled normal galvanized coatings in structure having the usual outer layer of unalloyed zinc as distinct from the very thick layers of zinc-iron compounds present in the coatings produced on the silicon-containing steels.

Coating Weights on Hot Galvanized Steel Angles in Relation to Time of Immersion

B. J. BARMACK
(Chairman, Subcommittee XIII of Committee A-5 on Corrosion on Iron and Steel, American Society for Testing Materials, U.S.A.)

THE work described in this paper was carried out to examine the requirements for obtaining increased weights of zinc coatings. Steel angles in three sizes and 3 ft. long were used as test samples and angles of each size were divided into four groups of ten specimens each. Each group of ten angles was then immersed in the galvanizing bath times ranging from 1.5 minutes for the first group of smallest angles up to 12.5 minutes for the last group of large angles.

Coating thicknesses were measured by Magne-gage and the readings were carefully averaged and calibrated.

From these tests, conducted in a very careful way so as not to disturb the distribution of zinc on the surface of steel, it was evident that the present requirement in ASTM specifications A123 of an average coating weight of 2 oz. per sq. ft. of surface is a reasonable requirement.

On small angles, $1\frac{1}{8}$ x $1\frac{1}{8}$ x 3/16 in. a time of immersion of $1\frac{1}{2}$ minutes is the minimum necessary to bring the steel to the temperature of the bath of 830°F. (443°C) and obtain a coating weight of $2\frac{1}{4}$ oz. By extending the time to 3 minutes a weight of $2\frac{3}{4}$ oz. was obtained. This increase in weight of coating is attributed to the rapid cooling of the steel and rather light run-off of zinc due to small cross-section of angle.

For heavier cross-sections of steel angles, the conditions for increase in coating weight do not appear as favourable. The heavier steel retains the heat much longer and, therefore, zinc runs off in greater quantity. For example for $3\frac{1}{2}$ x $3\frac{1}{2}$ x $\frac{1}{4}$ in. angles, doubling of time of immersion from $2\frac{1}{2}$ to 5 minutes resulted in increase from 22 to a little over $2\frac{1}{2}$ oz. Extending the time to 9 minutes resulted in an average coating of less than 3 oz.

For still heavier angles, 6 x 6 x $\frac{1}{2}$ in., an increase in immersion time from $5\frac{1}{2}$ to 12 minutes resulted in an increase in coating weight from $2\frac{1}{2}$ to 3 oz. only. The

rate of increase in weight of zinc coating seems to decrease with the size of the angle ; that is, the curve showing the relationship between the weight of coating and time of immersion flattens out significantly.

Note : in the revision of Specification A123, made in 1959, the weight of zinc coating per sq. ft. of actual surface, for ⅛ in. and 3/16 in. steels, was retained at 2.0 oz. average and 1.8 oz. minimum. But, for ¼ in. and heavier material, the coating weights were increased to 2.3 oz. average with no individual specimen to show less than 2.0 oz.

DISCUSSION

MR. J. F. H. VAN EIJNSBERGEN (Stichting Doelmatig Verzinken), opening the discussion, referred to Mr. Mantle's paper, and said that the author stated that galvanizing pots would be attacked more rapidly when galvanizing temperatures were raised above 480°C. However, this remark applied more specifically to steel pots, whereas ceramic pots were nowadays often used when articles (*e.g.*, nuts, bolts, etc.) were galvanized at 480-525°C.

Second, the greyish Zn/Fe-alloy coatings obtained on high-silicon steels were not only less attractive in appearance but tended also to develop a rust-coloured stain at the surface which was often mistaken as a premature rusting. In investigations of a number of such phenomena he never found any rusting of the steel base and even after several years of atmospheric exposure this stain did not cause any decrease of the layer thickness. However, the fact of an unsightly colour remained, and Mr. Mantle was quite right to mention this.

Third, he wished to draw attention to the fact that, apart from Switzerland and Sweden, the U.S.A. used silicon-steels to a large extent. Not only did they rust more slowly but corrosion was avoided in the majority of cases, and he had been informed that Sub-committee 5 of A.S.T.M. Committee XIII, under the chairmanship of Mr. B. J. Barmack, was now carrying out investigations on the galvanizing of such steels, and the Stichting Doelmatig Versinken was invited to assist in some of their experiments. It would be of interest to European galvanizers to obtain their results when this work had been terminated. Here again it was quite possible to achieve thicker layers by special galvanizing procedures which had not been revealed.

Lastly, while shot-blasting might appear attractive as a means of increasing coating weights, he wished to point out that this surface treatment might increase finishing costs considerably. In the Netherlands a very extensive research programme on blasting steel surfaces has been under way since 1958 and many problems of this very intricate matter had been resolved. While Dutch experiences were parallel to those given by the author there were several other variables in shot-blasting to be considered, *e.g.* the distribution of particle sizes, the blasting angle, the air-speed and the mechanical properties of the shot-surface.

Finally, a word of warning about blasting. In 1958, sand blasting in Holland was forbidden because of the silicosis danger, and the extensive tests referred to had been carried out by one of the Government laboratories,

DR. D. HORSTMANN (Max Planck Institut) said that Mr. Mantle had not given any figures concerning shot-blasting, and he wished to ask him what the various values were. Recently they had undertaken some experiments with cold matted galvanized sheets, which were blasted in various ways. Blasting had an effect upon the coating, even though the effect was not as great as they originally thought.

MR. ALLEN T. BALDWIN (The Baldwin Gregory Co.) referred to the fact that no discussion had occurred on the fluidity of the zinc bath. There was no intimation, for instance, that this was a pure zinc bath or whether it contained by intention or accident additional agents to delay the freezing, such as aluminium.

There had been considerable discussion on the matter of blasting. He was quite familiar with an organization that had done nothing but blasting of castings for almost 30 years, and to attempt to describe precisely what was the most efficient method was almost impossible because of the change in surface conditions, so that they had resorted to the use of an approved device for measuring either roughness or smoothness in terms of root mean square values.

MR. F. SOUSKE (N.V. Plaatwerkerij en Verzinkerij v/h P. Bammens & Zn) said that on page 2 of Mr. Barmack's paper there was no mention of the speed of withdrawal which would have a great influence on the coating thickness.

In Mr. Mantle's paper he was very surprised to find, that the speed of withdrawal was 10 to 20 ft. per minute. In practice he had found that the speed of 10 ft. per minute was far too great to get a smooth surface, and preferred a speed of 2 ft. to 3 ft. per minute and a longer dipping time.

AUTHORS' REPLY

MR. E. C. MANTLE, in reply, said that industrial trials on the shot-blasting of steel carried out since the paper was written, confirmed the results given but also gave a better idea of the order of increase in thickness obtainable in practice by a shot-blasting treatment. This again referred to steel angle 3 in. x 3 in. x ¼ in. thick, and the lengths

were 30 in. long. The steel contained 0.07 per cent of silicon and 0.15 per cent of carbon. The galvanizing was done by what they knew as the dry process at 450°C. with no aluminium in the bath, though the bath was saturated with lead. The vertical withdrawal speed was $7\frac{1}{2}$ ft. per minute. With these conditions of galvanizing a normal process when shot-blasting gave coating weights after two minutes' dipping of 2.2 ounces per sq. ft., and after five minutes' dipping 2.9 ounces per sq. ft. When shot-blasted with a mixture of a No. 16 grit and a No. 40 grit, which gave a medium coarse finish, the corresponding figures were : 2 minutes, 3.2 ounces per sq. ft. ; 5 minutes, 5.4 ounces per sq. ft. Shot-blasted with a No. 16 grit, which gave a somewhat coarser finish, the figures were : 2 minutes, 2.8 ounces per sq. ft. ; 5 minutes, 5.0 ounces per sq. ft. Shot-blasted in a Wheelabrator with the same grit size the figure were : 2 minutes, 3.2 ounces per sq. ft. ; 5 minutes, 6.0 ounces per sq. ft.

Although varying grit sizes had been used in these experiments, in fact when they came to do sieve analyses on the grit that had actually been in use in the machines for some time they found that there was not much variation in the grit size but that it all ranged between about 20 mesh and 60 mesh on the British Standard sieve sizes. He was not quite clear how they corresponded to sizes used in other countries.

He had added this as confirmation that in practice it was possible to obtain a substantial increase in weight by shot-blasting, although it was clear that more work had to be done before it would be possible to decide just how well the coating thickness could be controlled by this method.

He agreed with almost all that Dr. Eijnsbergen had said, but so far there had been no suggestion in Britain that ceramic pots would be welcomed for galvanizing large steel structures, although they might be suitable for handling small articles like nuts and bolts.

On the question of the stain produced by corrosion of the zinc-iron alloy layer with the high silicon steels he had seen many examples recently of this staining appearing which had caused the users quite considerable concern, although he did not think it in any way affected the life of the galvanized steel. He would await with interest the results of the work being carried out in sub-committee 5 of A.S.T.M. Committee XIII in America.

Lastly there was the question of the cost of shot-blasting. This, they envisaged, was a process that would be applied to large runs of structural steel work where the shot-blasting could be highly mechanized, and this would certainly help to keep down the cost. But he thought this was a point which the galvanizer must also use in selling the resultant article : he should make a point of the very much greater increase in coating weight achieved, and hence the long life of the article, giving material savings in painting and maintenance.

He had made no records of surface roughness, and perhaps that was something they could have usefully done to add to the value of the work. He had also mentioned that this roughening of the surface to a certain extent at least did improve coating adhesion, and this was something they had noticed before in other connections.

Replying to Mr. Baldwin he said that the baths were free from aluminium but contained lead and were, of course, also saturated with iron. He was interested that he also referred to surface roughness measurements and used these records as a means of deciding how to obtain the correct cutting weight.

Mr. Souske had mentioned the question of withdrawal speed. A lower rate of withdrawal would surely tend to give better drainage and therefore, if anything, thinner coatings rather than thicker coatings. He was not sure that he would go wholeheartedly with him on this question of very long dipping times, because in the work they carried out they found that after a period of immersion of about 5 minutes, or very little longer than that, there was not much gain in the thickness of alloy layer and coating thickness with increasing immersion times on the normal structural steels which had a low silicon content, although, of course, with a silicon-containing steel, coating weight continued to increase rapidly as the time of immersion increased.

Session 2a

Chairman : Mr. G. BRUCKNER
(Hutte Krems Ges. mbH)

Mechanization in the Galvanizing Industry

A. G. NORTHCOTT
(James Simpson and Co. Ltd.)

THE paper endeavours to focus attention and provoke discussion on mechanization within the galvanizing industry. The author illustrates his point of view by giving several interesting and revealing facts about the development of the industry over the last twenty years. Since 1938 the output of steel in the United Kingdom has been almost doubled, whereas the increase in output of the general galvanizing industry represents but a small proportion of this increased tonnage. Also in the galvanizing industry direct wages represent anything from 30 to 40 per cent of the total cost of galvanizing while figures for most other industries are lower, some being below 10 per cent of the total cost.

The author believes that consideration of these important general factors leads to two clear and unmistakable conclusions.

1. That the general galvanizing industry must make vigorous efforts to reduce processing costs if a prosperous future is to be assured.

2. That the most effective way of reducing such costs is to reduce labour costs by a rapid and widespread increase in mechanization.

The author briefly summarizes some aspects of mechanization in general galvanizing and outlines the selection, use and maintenance of equipment to give an efficient and routine programme of use.

A planned replacement programme is discussed and the many advantages gained by this type of forward looking policy emphasized. It is also useful to bear in mind that by the constant focusing of attention on mechanical improvements, management itself becomes forward looking and takes positive action to keep abreast with new developments and improved methods.

Mechanized Handling of Materials in Hot Galvanizing Plants

L. L. Boyles and W. M. Boyles
(American Hot Dip Galvanizers' Association, Inc. Washington U.S.A.)

THE authors describe the general methods of handling materials in eleven galvanizing plants in the United States. The plants include both job and captive galvanizers, selected as being representative of galvanizing operations throughout the country. The report is divided into seven sections and covers the range of handling required from shipping and receiving to quenching.

The majority of material movements were effected by fork trucks and automotive cranes or bridge cranes. In some plants where small work was pickled in boats, cages or drums, the pickled material was put on a sloping table narrowed at the lower end to form a lip or chute. The most advanced arrangement consisted of two chutes which extended from the pickle room to the galvanizing area and which were vibrated by eccentrically mounted electric motors.

Material was preheated at two of the plants visited both using the dry galvanizing process. In one shop, space above the bath was used to dry and preheat steel. Two 20-ft. angles were laid across the middle of the kettle one end resting on a steel saw-horse and the other on the far edge of the kettle. Material was laid on the cool end of this ramp and was pushed out over the zinc, where it was dried and preheated.

Quench tanks were used by five of the seven galvanizers who had small kettles. Of these five two used conveyors one used a self-dumping scoop and the remaining two used conventional manual methods of quenching. Of the nine establishments with large kettles, two did not have quench tanks and three used tanks set flush with the floor. Some of those above the floor level were mounted on wheels or tracks, allowing them to be moved out of the way if desired. One plant had a 15-ft. deep tank another had one 12-f.. deep and long material was dipped vertically into these.

A Note on The Emptying of Galvanizing Baths

R. Gloor
(Kummler and Matter A-G, Däniken, Switzerland)

A STUDY of the draining of galvanizing baths has resulted in a more advanced method being used by the authors company which replaces the more common practice of ladling the molten zinc from the failed baths. Drainage cocks have proved entirely satisfactorily in practice, particularly in view of the large numbers of baths operated and the high cost and lack of space for standby baths. In addition the size of the drainage channel and of the modulus has been increased to allow more rapid and easier removal of zinc from the largest bath. The smaller baths are also connected to the central catch pit and it has been found that there are no difficulties with drainage channels up to 15 m. long.

The drainage cock is positioned at one end of the bath above the drainage channel and can be readily opened with a winding mechanism which extends through the insulating wall. It must be robust, but its dimensions will depend on the flow rates required. Using the technique described, a galvanizing bath containing 150 tons can be drained completed in 20 to 30 minutes.

DISCUSSION

Mr. Michel Puech (Ste. Metallurgique de L'Aisne) said that the problem of maintenance was one of the most important daily problems they had to face, together with that of flow-rate throughout the galvanizing industry, and it was their desire to limit maintenance costs as far as possible, since they all knew, as Mr. Northcott had confirmed in his paper, that the maintenance costs accounted for 30 to 40 per cent of the total price in galvanizing processes, and therefore the need for specialization made it important to lower this figure considerably.

To refer to Messrs. Boyles' interesting nomenclature dealing with the characteristics of the galvanizing industry of the United States, he noted that crucibles were divided into two categories : those below 5 metres and those exceeding 5 metres in length. Little or no reference had been made to the rather large dimensions which were now frequently found in Europe. Were larger baths in use in the U.S.A. ?

Mr. E. M. Wilson (Henry Hope and Sons Ltd.), said that the galvanizing industry was always striving to discover a new material which was inert to the action of molten zinc, and experience had shown that only pure metals, as distinct from alloys, could be used. Furthermore, the metals which might be suitable were also very expensive, such as nickel, chromium and titanium.

Where some degree of mechanization was employed the problem was further complicated by the need for such material to be resistant to attack by either hydrochloric acid or sulphuric acid, and also zinc-ammonium-chloride flux. Nickel was reasonably satisfactory with zinc and hydrochloric acid. Chromium might be all right with zinc and sulphuric acid but was too costly. Titanium, provided the immersion time in the zinc was of limited duration, was probably the best.

He had first investigated the use of titanium in 1959, and a trial carrier was made and put into service in October 1959. This first carrier, had now completed 3,650 cycles before being withdrawn from service to be exhibited at the Conference.

The relative costs of mild steel and titanium were shown in a brochure published by I.C.I. and he

Delegates at the Conference examining the stand of GLUMA.

could assure them that the cost of using steel carriers in terms of heat lost and zinc wasted was just as high as stated.

Titanium had been compared with steel because steel was what galvanizers normally used. On their plant in England they had used plated carriers for about ten years which had enabled them to reduce the carrier cost by about a third. The cost of a steel carrier had worked out over the years at about £31 per thousand dips. By plating this could be reduced to about £20, and on current titanium prices a titanium carrier would work out at about £7. It should be noted that their experience related to dry galvanizing, which involved degreasing, washing, cold hydrochloric acid pickle, ammonium chloride flux, followed by immersion in the zinc, the immersion period in their case being less than three minutes. Should the immersion period be considerably greater—say over ten minutes—the titanium, he believed, might suffer some erosion due to this prolonged immersion, as at some point with molten zinc there was an appreciable effect.

MR. F. GOTZL (Brunner Verzinkerei Brüder Bablik), referring to the attempts at mechanizing in the galvanizing industry, said that Professor Bablik had done brilliant work in this field, as in others. His experience showed that various groups of galvanized objects, such as wire, rods, etc., because of their similarity of structure, were likely to be suitable for mechanizing, and in many instances this had already been done. An additional group were the so-called small parts, particularly nuts and bolts. The emptying of baskets and the quenching and stacking were done on a continuous conveyor belt system. A number of partial solutions had been found but a fully satisfactory one had not. Automation would call for a certain standardization of the items to be galvanized and it was the duty of the individual industry to find out whether there were a sufficient number of parts available which, both as to form and as to dimension, would be suitable to be transported in a conveyor belt system, because this would be probably the only type of automatic system to be used.

MR. KURT LEWUS thought that the figures for wages given in Northcott's paper were too high at 30 to 40 per cent. In Germany a typical figure was less than 10 per cent in a non-mechanized plant.

MR. ALLEN T. BALDWIN (The Baldwin Gregory Co.) said that kettles up to 35 ft. or possibly 40 ft. long were in use in the U.S.A. There were a great many in the range from 27 ft. or 28 ft. to 35 ft., and varying generally from 36 in. to 48 in. in width, and seldom less than 60 in. deep. The deepest one he knew of the large size was in one of the shipyards. It was deep enough for them to be able to galvanize 8 ft. of a section of a battleship hull.

There had been some discussion on mechanization. In the United States (outside of that field which was easiest to picture, namely, wire, tubes, strip) the progress was slow, because it was realized that, whether one mechanized or did the work individually, the cost of zinc per ton of work should be the same, so that therefore one stood little chance of gaining anything by mechanizing. It resolved itself then largely to a question of labour cost, and again one got to a minimum working force and a general jobbing plant or plant doing diverse work deciding that it cost them so much an hour to operate a kettle, and they would divide that as against possible production and it

soon told them that it was doubtful if any great degree of mechanizing would result in a substantial saving, because the work changed too rapidly from hour to hour.

MR. OTHMAR RUTHNER (Firma Ruthner, Elektro-Chemisch-Metallurgische Industrieanlagen) said that on the basis of practical experience he believed that a standardized clean surface was the pre-requisite for the success of galvanizing. His company were in a position now, in spite of the problems of water pollution, to create conditions to make uniform galvanizing possible and also to make certain mechanical processes possible which could not be introduced at present.

AUTHORS' REPLIES

MR. A. G. NORTHCOTT, in reply, said that he was more convinced than ever that the problem of mechanizing was the problem of the industry's future. At this point he wished to distinguish between mechanizing and automation. He believed that they had a very long way to go before they could start considering automation in the galvanizing industry, but he believed that mechanizing was something that should occupy their thoughts for the next decade or even more. He was more convinced than ever that they could not do this adequately unless they got together on a regional basis and achieved some sort of integration which would provide a means for more specialization. This, he was convinced, was the necessary qualification for survival. His own company now had an average selling price of 62 per cent less than three years ago. There were a number of reasons for that. It was not just one simple one. If they were not operating with a 38 per cent reduction in labour force and 100 per cent increase in tonnage they would have been out of business before now. That sort of situation would become even more common in the future unless they had what he had brought out in his paper as an essential necessity.

In his own company, despite the quite considerable reduction in labour force, their operating percentages at the last analysis were 39 per cent labour cost, 33 per cent material cost and 28 per cent overhead cost.

MR. ROBERT GLOOR, in amplification of his paper on the emptying of galvanizing baths, said that galvanizers, as they all knew, were continuously making efforts to keep their processes to the briefest possible time limit. Their concept was the result of the fact that they had a varying number of dimensions in their industry. There were nine different sizes of bath which were used for different processes, and it was therefore particularly important that with wages being such a factor they should keep down the time to the minimum. In the case of mechanized industry which dealt with rods or galvanized such rods and had stand-by baths etc., for the purpose, it was much simpler, because the stand-by bath was put into operation in such cases.

During the last 12 years his company had operated a transport system which moved small objects by an automatic process. It could be run at eight different speeds, so as to make it possible to have the galvanized coating applied according to the thickness desired. Switzerland was too small a country to introduce mechanizing to the extent that it might be possible in countries like the United States.

As regards wages, in his firm the total wage cost amounted to roughly 30 per cent, but galvanizing as such was based on different methods in various countries, and the thickness of the coat, the finish, and so on, were not necessarily comparable. The cost of the zinc might be more or less comparable but there was a tremendous variation in wages and in standards of living.

Session 2b

Chairman : MR. O. GRAVERSEN
(Odense Jernrarefabrik)

The Effect of Hot Galvanizing on the Mechanical Properties of Steel Sections

H. WIEGAND
(Technische Hochschule, Darmstadt, Germany)

THE author considers the effect of protective treatment on the mechanical properties of the materials which tend to alter the behaviour of the structural sections under working conditions. The reactivity between steel and molten zinc increases with increasing carbon and silicon in the steel. The consequential growth of brittle and harder iron-zinc alloys affects the properties of the steel and so high carbon or silicon steels, especially silicon-killed steels, are generally avoided. It is shown however that it is unwise to reject silicon-killed steels altogether, although aluminium should be used for deoxidation to avoid undesirable ageing effects.

The rate of loading greatly influences tensile strength and ductility. This effect becomes more pronounced as the influence of construction shape increases. Faster loading rates raise both the yield point and tensile strength but this is true of ductile materials only, when notches are present. Results obtained from galvanizing aged steel indicate that there is no marked change in the impact resistance of the aged specimen even after long immersion in zinc at 440°C. Only by heating to temperatures above 800°C can the transition temperature be lowered. It is also shown that galvanizing slightly improves the tensile fatigue limit of a butt welded joint but decreases the fatigue strength of a cross type welded section. Alloy brittleness may occur in hot galvanizing, similar to that found in hard soldering. The major factor is the critical tensile stress present in the section to be galvanized, whose magnitude will depend on the steel composition and the design and method of assembly of the structure. The immersion or wetting time in the molten zinc is also important but the individual significance of each of the various factors has not yet been established.

Current investigations have shown that, provided certain precautions are observed with regard to choice

of plate material and also construction and processing technique, the operational behaviour of structures subjected to impact or fatigue stress will be little impaired by galvanizing.

DISCUSSION

MR. W. L. HALL (General Galvanizers Ltd.) referred to Professor Wiegand's statement to the effect that it was not recommended to quench galvanized coatings in water immediately after the articles were removed from the bath, because there was a danger of forming cracks thereby in the coating, and impairing the fatigue resistance. This was a very sweeping statement and he would be interested to know the supporting evidence for it, apart altogether from the question of holloware, which was not subjected to any particular stress. Many tons of small fittings and sections which were subjected to fluctuating stresses in service were so treated after galvanizing, and he had never had any evidence brought to his notice that such a treatment was dangerous.

MR. E. C. MANTLE (British Non-Ferrous Metals Research Association) said that he, too, was very interested in this question of the effect of galvanizing on the fatigue properties of steel, because it was rather difficult to predict from theoretical considerations what was going to happen, because the zinc had about twice the coefficient of expansion of the steel, so that on cooling the zinc coating would be under a certain amount of tension, but, on the other hand, the difference in Young's modulus between zinc and steel was such that for a given amount of bending on a galvanized specimen the amount of stress in the coating was very much less than the corresponding stress in the steel for a given deflection. Most previous papers had pointed out that galvanizing generally lowered the endurance limit, but this seemed to be because other people had probably compared the results of galvanized specimens and polished steel specimens, and he was sure that Professor Wiegand had the right idea here, where he considered the properties of an " as received " specimen with the mill scale still on it, with the corresponding endurance limit of the material after galvanizing. This did show that galvanizing if anything increased the endurance limit, but he was not quite clear why this improvement still persisted after the galvanized coating had been removed by pickling. Could Professor Wiegand say whether this was just a question of the smoothing out of the pits and so on that were in the steel, resulting from the removal of the mill scale, or was there something more subtle to it than that ?

AUTHORS' REPLY

DR. W. RADEKER (Phoenix-Rheinrohr A.G.) replying on behalf of Prof. Wiegand and referring to the effect of quenching upon the galvanized surface itself, said that he did not think that there were any important effects arising out of quenching, because the zinc was still largely ductile during the quenching process. It was only once it had reached a certain low temperature that its ductility was somewhat impaired, but then the iron too was affected, and therefore the difference in plasticity led to deformation of the zinc first of all and then together with the iron.

With regard to the second point raised by Mr. Mantle, the comparison with a polished specimen, *i.e.* the effect of zinc on the ductility, here they must carry out certain very basic experiments still, because after galvanizing and removing the item somewhat rapidly from the bath it was found that the differential cooling process led to internal stress. It depended upon the internal stress whether there was greater stress on the surface or not. One found a certain effect upon the endurance limit and then one believed that this was due to the zinc as such. It was actually due to the internal stress as such.

The Adhesion of Galvanized Coatings

H. BABLIK, J. KRYSTOF, F. GOTZL
and
E. NELL
(Brunner Verzinkerei Brüder Bablik, Vienna, Austria)

A ZINC coating is formed by immersion of the iron base in molten zinc. Metal-to-metal contact is ensured by pretreatments such as acid pickling or gas cleaning, followed by fluxing immediately prior to immersion, its purpose being to dissolve all non-metallic substances present on the metal surfaces and enable the reaction between metallic zinc and metallic iron to proceed. In order to produce coatings which will stand high stresses due to bending, sheets or strip are usually immersed in baths containing approximately 0.1 per cent aluminium. Articles which have to resist impact are normally galvanized in aluminium-free baths.

The authors discuss the types of stress to which the coatings may be subjected and give many photographs of the effects on the coatings. Many different types of coating tests are described and much information given in tabular form on the properties of various types of sheet. The effect of roughening is demonstrated by comparing galvanized cold-rolled sheets. Those sheets having a short hydrochloric acid pickle were smooth while sheet pickled in nitric acid showed pronounced roughening. It is also possible to conclude from the paper that mechanical roughening or filing does not affect coating adhesion. It also seems that carburizing the steel has no effect on the coating adhesion, although it is known that Crapo-galvanized wires which are carburized have exceptionally good coating adhesion qualities. Some of the adhesion values obtained are listed in a table.

The authors conclude that although further work is necessary, the experiments already carried out indicate that the chemical and physical properties of the reactants have an influence on coating adhesion. It is also fairly certain that impurities and alloy additions greatly affect the density of dislocations and therefore the rate of diffusion, which determines the structure and form of the

alloy layers and in turn, affects the bonding between the phases. The interphase reaction rates have not been investigated but it is believed that the influence of impurities on these rates is negligible compared with the influence of small amounts of impurities on the density of dislocations and hence on the diffusion rate.

DISCUSSION

MR. RAYMOND C. BELL (Consolidated Mining & Smelting Co. of Canada Ltd.), said that the statement was made that " pure zinc is always preferable if good adhesion and flexibility are required " ; also that " re-melted zinc with its additional impurities is really unsuitable for galvanizing." The paper went on to say that " even the trace impurities in the electrolytic zinc affect the final adhesion values, and variations in the nature and amount of these impurities cause variations in the results." Since this point had been much stressed in the latter part of the paper he thought it would be most helpful if they could have the analysis of the various basic electrolytic zincs which were concerned in this particular paper.

It had also been stated in this part of the paper that lead added to the bath had a pronounced effect on the adhesion of the coating ; a detrimental effect but evidently a variable effect, and one which was further influenced by the type of zinc to which the lead was added. This was another reason why he thought it would be most interesting to have the analysis of the zincs.

This effect of lead, just to pick out one element in particular, was somewhat surprising to him. It was not particularly in agreement with results of his own work and that of many other investigators, though admittedly, he had used different types of test from the rather unusual test which the investigators had used in this present work.

MR. E. C. MANTLE (British Non-Ferrous Metals Research Association) thought the paper really revealed Professor Bablik's true enthusiasm for his subject but, as with many of these rich meals, he found that this one gave him a little mental indigestion. Perhaps in some places his enthusiasm had run away with him, for on page 7 of the English translation, for instance, there was a discussion of the life of galvanised coatings with a suggestion that they lasted so long anyhow that it was not worth while worrying about trying to put on thicker coatings. This might be true of a place or country like Austria or Switzerland but it was not true of many industrial areas, where they would not expect a two-ounce coating to last more than perhaps seven years before quite noticeable rusting occurred. In fact, on the way up from Zurich he was quite surprised to see that some of the galvanized steel transmission towers there, even in that very pure atmosphere, were showing serious signs of rusting. He had no idea how long they had been up. The point he really wanted to ask about was the one Mr. Bell had already dealt with, the effect of lead in the zinc on the adhesion of the coating, because Dr. Bablik's results were quite at variance with those obtained by the British Non-ferrous Metals Research Association when they examined the question about four years ago. They were then concerned with a rather different aspect of the problem, because this question of galvanizing in electrolytic zinc or in zinc containing lead primarily affected people doing continuous galvanizing, sheet or strip or wire, and so in their own they confined their attention to cases where the galvanizing time was very short, a matter of seconds, and where the bath contained the normal amount of aluminium for this sort of work, about 0.05 per cent. Therefore they found that lead had no detectable effect on either the ductility or the appearance or the coating weight, or even the corrosion resistance. The adherence and ductility was judged by a bend test in the case of the strip to determine the minimum radius of bend over which the material could be bent without the coating cracking or flaking. There was a similar test on wire where the wire was rubbed over itself, but with these tests and with short immersion times they could find absolutely no effect at all that could be attributed to lead, although they did find a very noticeable effect due to the differences in the surface roughness of the steel. This had a much more potent effect on adherence and ductility than the lead or the composition of the zinc used, and quite frankly he was a bit suspicious of the test shown in Fig. 16, because he could not quite envisage how that worked. It seemed more like a soldering test than anything else. It was also perhaps rather revealing that in Figs. 24 and 25 there was a very marked effect from the addition of lead to the electrolytic zinc, whereas in a later experiment, Fig. 27, this effect was scarcely noticeable.

MR. D. I. CAMERON (John Lysaght (Australia) Pty. Ltd.) said that he was, in many ways, in agreement with the previous speakers concerning the new test that was outlined in this paper as a means of measuring the adhesion of galvanized coatings. It did seem that adhesion, as it was spoken of here, was a rather different thing from the adhesion normally dealt with when bending a coating, and in this case cracking in the alloy layer was liable to interfere and bring about drastic effects as a result of the bending operation, because of the cracks which formed in the coating permitting things to happen at stresses which were very much below even the lowest of the ones that were given in the paper by Dr. Bablik and his workers.

They had, for example, tested under production conditions over 100 loads of steel sheets, each of several tons, dipping them in a bath with lead and a

little tin but no aluminium. Folding tests were carried out over four thicknesses, a seaming test with a commercial apparatus or Youngstown test. From a statistical analysis the folding test responded a little differently from the seaming test or the Youngstown test, in both of which the surface of the steel base was probably rather nearer to failure because of the greater amount of work.

The beneficial effects of silicon in the steel which the authors had mentioned showed up on the seaming and the Youngstown test but did not show up on the folding test. There was found to be a beneficial effect of high temperature in the acid bath ahead of the pot for all methods of tests.

It was also established that the adhesion was affected by one of the variables in the rolling and also by one of the annealing variables, but they were not sure which of them.

MR. HAROLD EDWARDS (John Summers & Sons Ltd.) said that he could not let this occasion pass without a reference to the late Dr. Bablik. He had had the privilege of editing the last edition of Dr. Bablik's book on galvanizing in English, and came to know him intimately as a scientist and a friend.

The reference to the mechanism of aluminium in zinc baths was appropriate and important. The statement that " it is quite inaccurate to advertise galvanized sheet and strip as withstanding bending or stretching without damage " was possibly a warning, but within the limits of general practice the tight-coated quality sheet was non-flaking. The reference to the " hammer test " was interesting but he wished to mention the " impact test " referred to in the paper presented to the symposium on the " Production of Wide Steel Strip " (I. & S. I. 1960) by Jenkins, Harry and himself. The impact test consisted of producing a 5/16 in. deep cup by means of an 0.84 in. diameter punch with a hemispherical end attached to a falling weight. This test had been found to be severe and discriminating. If flaking occurred the extent was classified by the use of standards and the product was allocated accordingly. The test was used for quality control in his works.

The new test, devised by the late Dr. Bablik and his colleagues, was most interesting. What steel was used for the rods which were used in this equipment ?

The effect of nitric acid treatment was dealt with in the paper and the figures were informative, especially those for Phenix sheet with a coating adherence of 6.5 kg per sq. mm for untreated, and with 11.8 for the treated sheet. What was the strength of the acid, and the times of immersion and the temperature ?

The use of a silicon treated steel for galvanizing should be approached with caution because of the sometimes detrimental effect of silicate inclusions on ductility. Adhesion was far superior on smoother cold-rolled sheets, and this had been confirmed by work at John Summers.

MR. H. BRIDIER (Société Lorraine de Laminage Continu) referred to page 7, where the term " beard formation " was used, and asked for additional information on this. The results indicated there also appeared startling for certain types of steel. Which were the types of steel likely to give this growth and which were the ones which did not ?

AUTHORS' REPLY

MR. FRANZ GOTZL (Brunner Verzinkerei Brüder Bablik) discussing testing procedure said that first of all a normal sheet was tested with a chisel and a photo micrograph of the impact was made. It was of interest to find that the coating together with the iron was deformed in a downward direction, and the zinc coating had undergone relatively little change. There were a few cracks. A second test was carried out on a cold-rolled sheet in a similar manner, and the basis sheet was not deformed. The flexibility of the sheet affected the adhesion of the coating.

The nitric acid test, was simply to provide a form of roughening.

When an electrolytic zinc was used the figure was 99.9 per cent and there was no close analysis. A number of impurities were added to various electrolytic zinc baths and with small additions the adhesion was considerably impaired. Further additions caused a relatively minor further reduction The addition of magnesium was not desirable for various other reasons.

The effect of lead on the adhesion of zinc, depended, of course, on the type of test used for this purpose. They had confined themselves to the primitive, simple, test, the adhesion of the coat, and here it was found that lead, even in small quantities, had a noticeable effect on the adhesion of the coating. The figures they found had been tested repeatedly and did not seem to be open to dispute in this context. The method might not be the customary one and the effect in actual practice might not be borne out everywhere, but this was not the original intention, because they must first of all start somewhere to get comparative figures.

All the electrolytic zinc was basically 99.99 per cent but the degree of adhesion varied.

As regards the effect of quenching on adhesion, it was, of course, true that the speed of quenching was of importance in this context ; the essential results obtained were achieved under comparable conditions and the fact that the speed of quenching

(*Continued in page* 386)

THE INFLUENCE OF INTERNAL — STRESS ON CRACK — FORMATION IN NICKEL DEPOSITS

by T. E. Such B.Sc.*

(One of the Lectures presented at the Borough Polytechnic, London at a One-day Symposium on "Internal Stresses in Electrolytically Produced Coatings and their Influence on the Properties of the Basis Metal," and published by permission of the Principal).

Introduction

DULL nickel as normally deposited is in a state of tensile stress and the effect which this phenomenon can have in producing cracks in nickel electrodeposits is the chief subject of this article. As nickel plus chromium coatings used for decoration and corrosion protection, rather than for engineering purposes are to be dealt with, some discussion on the physical properties of chromium plate is also necessary. It must be understood that the kind of cracking discussed in relation to stress is of the spontaneous type *i.e.*, cracking not induced by any external stress, such as would be caused by bending or other deformation of the plated article. However, cracking caused by corrosion occurring in service will be included.

If a deposit has an internal stress, this is of course a measure of the tendency of this deposit to become shorter, but if it is firmly adherent to the basis metal, this shrinkage cannot occur provided the plated article is rigid. A certain amount of plastic flow of the deposit, varying with its ductility, can take place, but if the tensile stress is greater than the tensile strength, then cracking is bound to occur. Therefore, although the internal stress present is important the other physical properties of the deposited metal cannot be ignored, as they are equally vital in deciding whether or not the deposit will crack. However, it must be emphasized that there is absolutely no relationship between stress and ductility. A ductile deposit may have a high tensile stress, while a brittle one may have a very low tensile stress or even be compressively stressed. The combination of high stress and low ductility is to be avoided, for this is the one which leads to cracking.

Nickel Deposits

Some years ago the author was controlling the stress and ductility of nickel plate being given by various solutions used for production plating[1]. It was found that there was an empirical ratio between stress and ductility on certain articles that were being plated regularly, which, if exceeded, was likely to result in cracking. It was much easier to set a safe maximum figure than to be definite about when cracking would occur and values for safe stress/ductility ratios varied between different articles being plated in the same nickel solution. This critical ratio was of the order of 12,000 for steel articles and 24,000 for zinc base-die castings, with stress given in lb. per sq. in. and ductility as percentage elongation. These are approximate figures only, which are most probably not universally applicable, yet they were of great help then and still give an indication of how much stress can be withstood by a fairly brittle deposit. The difference between steel and zinc alloy might well be due to their different thermal expansivities as will be discussed later. On this basis a nickel deposit with an elongation of 2 per cent. plated onto steel should then withstand an internal stress of at least 24,000 lb. per sq. in. before cracking. Even then cracking cannot occur until the tensile strength of the nickel is exceeded. On the face of it spontaneous cracking might seem to be impossible for the usual relation between ductility and tensile strength holds good for nickel deposits —the more brittle deposits having the highest tensile strength. Thus deposits with elongations of less than 3 per cent. have tensile strengths of over 150,000 lb. per sq. in., yet they crack with internal stresses of much less than this.

Two explanations can be put forward for this. Firstly it is believed that the stress values normally recorded are the average for the area under test and it is probable that the internal stress can be locally much higher than these average values and so locally exceed the tensile strength of the deposit. Alternatively or perhaps co-existing with the first suggestion is the fact that we are not dealing with a homogenous metal, but with an electrodeposit which might well be locally weakened by some

*W. Canning and Co. Ltd.

inclusion, porosity or other defect in the plate. Perhaps even the well known laminations frequently encountered in bright nickel plate are zones of weakness. It may be said that these same arguments should apply equally to Watts dull nickel before its usual stress increases until it slightly exceeds its tensile strength of about 55,000 lb. per sq. in.

A ductile Watts nickel will not crack with internal stresses which do not exceed its tensile strength, while the stronger bright nickel will crack with stress of half this amount. The reason for this may be that the dull nickel is more ductile and so readily undergoes plastic deformation, as can be seen from Table I, and this prevents any undue stress concentration building up locally. This relief cannot occur with the more brittle bright nickels. Therefore it must be repeated that when considering the likelihood of nickel plate cracking, not only its internal stress but also its ductility and tensile strength must be known.

Table I

Typical Physical Properties of Watts and Bright Nickel

Type of Nickel	Ductility (Percentage Elongation)	U.T.S. (lb. per sq. in)
Watts	20	55,000
Bright	1	200,000

So far spontaneous cracking in nickel deposits has been considered as being that cracking observed in the plate almost immediately after being taken out of the plating solution and caused entirely by the internal stresses inherent in such an electrodeposit. In actual fact this can only be strictly true if the plating solution is at ambient temperature, otherwise there is a change in the strain put upon the nickel by differential shrinkage of the basis metal and the nickel deposit on cooling due to their varying coefficients of expansion.

It might be thought that this stress due to cooling would be additional to any internal tensile stress that was already present. However this can only be the case when nickel is plated onto metals having a lower coefficient of expansion and fortunately electrodeposited nickel has a fairly low coefficient of linear thermal expansion of about 13.4 x 10^{-6} per °C. Therefore of the metals commonly plated, only steel has a coefficient of expansion which is slightly less than that of nickel.

Even with steel as the basis metal the extra stress can usually be neglected, for if one is plating nickel at 135°F., and the room temperature is 65°F., the additional tensile stress due to cooling will be only just over 2,000 lb. per sq. in. However if the basis metal has a greater expansivity than nickel, for example brass, the compressive stress induced by cooling over the same temperature range is about 6,500 lb. per sq. in. and this must be subtracted from, not added to, the tensile stress originally present in the nickel. The stress relief would be even greater if a zinc alloy-die casting were being plated, as this material has a coefficient of expansion more than double that of nickel. For nickel plating onto zinc alloy this would result in a compressive stress due to cooling of approximately 19,000 lb. per sq. in., a considerable amount to set against the deposit's tensile stress. If this 19,000 is added to the 2,000 lb. per sq. in. tensile stress produced by cooling nickel plated on steel back to room temperature then this gives a total of 21,000 lb. per sq. in., which is of the same order of magnitude for the apparent difference in safe maximum internal stress found in practice between steel and zinc alloy when being nickel plated. The resultant stress left in the nickel plate after cooling would actually be the same for both metals. Therefore the difference in shrinkage experienced on cooling is often of benefit in preventing this kind of spontaneous cracking, not detrimental as sometimes presumed.

Table II

Coefficients of Linear Thermal Expansion
(Over range from 20 to 100°C.)

Metal	Average Coefficient (Per °C. x 10^{-6}.)
Steel	11.7
Electrolytic Nickel	13.4
Copper	16.7
Brass	18.9
Mazak zinc alloy	29.0

Although we are not concerned with cracking caused by bending of a plated article, it is relevant to note that any externally applied stress will be additive to the internal stress already present in the plated nickel. Therefore a strain which would not normally fracture a deposit may perhaps do so, if it is applied so that the resultant stress is in the same direction as the original stress. Of course, on the other hand, a stress applied in the opposite direction which was greater than the tensile strength of the metal might not cause failure, if it were opposed by the internal stress, the value of which could then be subtracted from the applied stress.

The type of nickel plating solution used makes a vast difference to the amount of internal stress present in the deposit obtained. Even when dull nickel is being plated, the composition of the solution chosen can result in wide variations in internal stresses. For example the level of tensile stress in nickel plated from a Watts-type solution containing both nickel sulphate and chloride is

directly proportional to the chloride content of the plating bath. This linear relationship was clearly demonstrated by Brenner and his colleagues[2] and the stress was shown to rise as the proportion of nickel present as chloride was increased. It can be seen from Fig. 1 that the stress increases from a value of 16,000 lb. per sq. in. for a solution containing only nickel sulphate and no chloride to 48,000 lb. per sq. in. for an all chloride solution. Basing a nickel plating bath on anions other than sulphate or chloride will also give deposits with differing stresses, although evidence available to date indicates that they will still be tensile, even if much lower as in the case of nickel sulphamate. Table III is taken from the work of Kushner[3] and all the values given are on the tensile side.

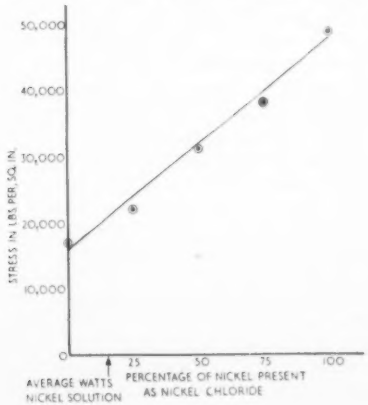
Table III

Tensile Stress in Nickel Deposited from Various Solutions 0.001 in. deposit plated at 77°F. and 30 amp. per sq. ft. (solution —1M in nickel metal ; 0.5M in boric acid) pH 4.0.

Anion	Tensile Stress (lb. per sq. in.)
Sulphamate	8,600
Bromide	11,300
Fluoborate	17,200
Sulphate	23,100
Chloride	33,000

If we now concentrate on the Watts type of nickel solution which is most commonly used both for dull deposits and as a base solution for bright nickel plating, we find that the acidity of the bath is most important. Not that varying the *p*H in the normal range between 3 and 5 makes much difference, but once the solution becomes less

Fig. 1.—*Variation of stress of nickel deposits with chloride content of plating solutions (Brenner, et al*[2]).



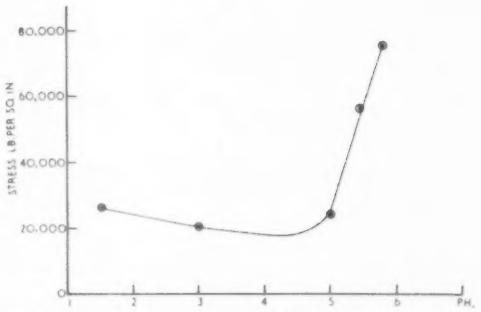


Fig. 2.—*The effect on stress caused by changing pH in a Watts nickel solution (Brenner et al*[2]).

acid than *p*H 5.0, the tensile stress rises rapidly and in fact is quadrupled by the time *p*H 5.8 is reached[2], as Fig. 2 shows. Alteration of the current density and temperature used for plating does not change the stress unduly, provided that one uses the optimum operating conditions that are normally chosen primarily for other reasons. There is definite evidence that the lower the temperature of plating the higher the stress, and stress at the temperature of the plating bath is meant, and there are indications that the same applies to current density, but unless very low currents or temperatures are used, their effects on stress are small.

Undoubtedly the greatest factor influencing internal stress is the composition of the plating solution and that does not only mean major constituents such as discussed above but compounds present in very low concentrations. Many people would include traces of metallic impurities in the plating bath as being responsible for raising stress, but only iron seems to have been thoroughly investigated. In the one controlled experiment on other metals to which a reference[4] could be found, Martin claims to have demonstrated that lead, zinc, copper and even hexavalent chromium have little effect on stress, although he used only 1.7 p.p.m. of chromium compared with 200 p.p.m. of copper and 320 p.p.m. of zinc. However, there is ample evidence in the literature that iron and particularly the more soluble ferrous iron can raise stress[5] appreciably. For example Curkin and Moeller[6] have shown that 100 p.p.m. of ferrous iron increase the tensile stress by about 6,000 lb. per sq. in.

If Martin is correct, it is most probably the presence of traces of organic materials that make it so difficult to obtain consistent figures for internal stress of plate from even simple nickel solutions unless these are extensively purified. A pure Watts nickel solution should give nickel plate with a tensile stress of 20,000 lb. per sq. in. However if a solution is prepared either from "Analar"

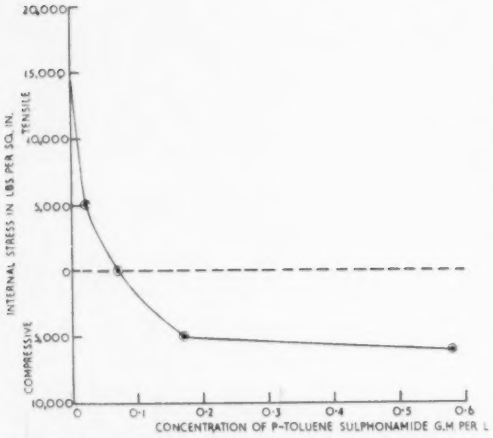


Fig. 3.—The effect on stress caused by adding p-toluene sulphonamide to a Watts nickel solution (Hoar and Arrowsmith[7]).

chemicals without any purification treatment or else from commercial grade chemicals and then given the usual carbon, hydrogen peroxide and high *p*H treatments, one usually finishes with deposits having stresses between 30,000 and 40,000 lb. per sq. in. In order to obtain the correct lower value, much low current density plating-out is needed. Organic compounds would seem to be responsible for most of this trouble, for many of them are even more potent than inorganic salts in altering the stress obtained. An example is the well known stress-reliever *p*-toluene sulphonamide, of which only 100 p.p.m. is sufficient to alter the usual tensile stress of a pure Watts nickel to a compressive one, a net change in stress of about 20,000 lb. per sq. in. (*See* Fig. 3, taken from the work of Hoar and Arrowsmith[7]). Unfortunately other organic materials have just as marked an effect in the opposite direction if they get into the plating solution. If dull nickel plating is being carried out, then stress raising chemicals should be absent, if the solution is correctly maintained and cared for. However the position is by no means the same for the bright nickels marketed as proprietary processes. Without the organic chemicals present a bright nickel deposit would have little lustre or levelling, but these same chemicals that have such a beneficial effect in this way are certainly detrimental in their effect on the physical properties of the deposit. They simultaneously raise the tensile stress and lower the ductility of the deposit. Fortunately the so-called secondary brighteners counteract these effects and are particularly effective in relieving the stress. While many organic compounds lower tensile stress slightly, the sulphur-containing ones are the most active. The use of such chemicals as saccharin, *p*-toluene sulphonamide and the benzene and naphthalene sulphonic acids for this purpose is well known. Table IV illustrates what happens, when first a typical proprietary secondary brightener, containing one of these sulphur-containing chemicals is added to a Watts nickel solution that was giving a ductile, but stressed deposit — how both the ductility and stress fall. When a full bright nickel is obtained by adding the primary brightener, then the stress tends to rise again, although not to such a high figure as before, but the ductility falls yet again. However, in spite of this lack of ductility, cracking will never be encountered with a modern proprietary bright nickel solution, providing it is properly controlled, for as Table IV shows they are formulated so as always to have low stress.

Table IV

Solution	Appearance of deposit	Ductility (per cent.) Elongation)	Stress (lb per sq. in.)	Hardness (V.P.N.)
(a) Watts Nickel	Dull	30	30,000 (Tensile)	200
(b) Secondary brightener added to (a)	Semi-bright (No levelling)	6	3,000 (Tensile)	450
(c) Primary brightener added to (b)	Fully bright and levelled.	3	7,000 (Tensile)	550

Chromium Deposits

Having dealt with the undercoat of nickel, now let us consider the top coat of chromium, usually applied for decorative purposes. Electrolytic chromium is not ductile, for it will not undergo any plastic deformation and any extension in the elastic range must be less than 0.1 per cent. As normally deposited from a chromic acid solution at about 100 to 110°F., thin chromium plate will be very highly stressed, with internal tensile stress of up to 180,000 lb. per sq. in. One might think that as the maximum published value for the tensile strength of chromium given by Brenner *et al*[8] for these same type of deposits is only 80,000 lb. per sq. in., that these chromium layers would obviously be cracked ; for it would be impossible for them to be crack-free with the stress over double the tensile strength. In fact, providing they do not exceed a certain specific thickness, of the order of 0.00004 in., these thin chromium deposits remain uncracked. The answer may lie in the fact that tensile strength has to be determined on thick deposits of chromium whereas the stress can be found on very thin coats. By analogy with electrodeposited nickel it might well be the case that the tensile strength of thin chromium coats could be much higher than the

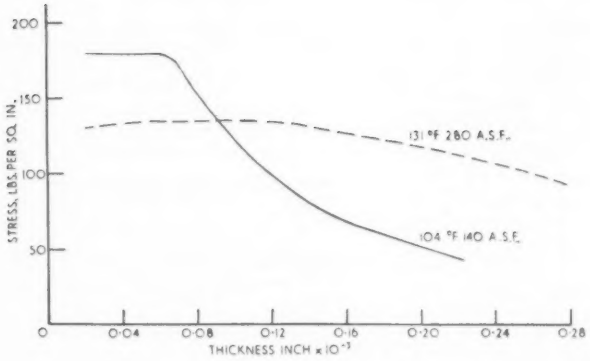


Fig. 4.—Stress as a function of thickness in chromium plating (Fry[9]).

values for much thicker ones published by Brenner who himself says that " the results on tensile strength of chromium are a measure of the soundness of the deposit."

Various explanations have been put forward to explain why uncracked chromium should have a limiting thickness. It has been said that cracking was due to stress increasing with increasing thickness until the tensile strength of the deposit was exceeded. Fry[9] has pointed out that even in uncracked deposits stress tends to decrease rather than increase. He postulates that striations of adsorbed foreign matter appear to be included at regular intervals in chromium deposits and that these form planes of weakness, where the tensile strength is lower. Cracking therefore starts in these planes and initiates, by the notch effect, cracking in the remainder of the deposit.

Whatever may be the cause of spontaneous cracking, the actual thickness at which cracking occurs depends on three factors and can be increased by raising any one of them or preferably all three together. These are :—

(1) The temperature at which the chromium is deposited.
(2) The ratio of chromic acid to the catalyst present.
(3) The concentration of chromic acid in the bath.

Thus, depending on what conditions are used for plating, deposits of crack-free chromium of quite substantial thickness can be built up as demonstrated by Edwards and his colleagues at the British Non-Ferrous Metals Research Association[10], when they investigated these H.T.H.R. crack-free chrome solutions ; H.T.H.R. standing for high temperature, high ratio. Faust and Safranek[11] at the Battelle Memorial Institute have been working on the same problem and reached similar conclusions. These conclusions are that to eliminate the cracking produced in chromium when deposited to an average thickness of 0.00003 in. at the commonly used conditions of 100°F. and chromic to sulphuric acid ratio of 100 to 1, it is necessary to increase both the temperatures and ratio used to a certain extent. However, the higher the concentration of chromic acid in the solution, the less these other factors need be raised, making for easier practical application. For example, the same benefits of freedom from cracks can be obtained by using a 450 gm. per l chromic acid solution at a temperature of 115°F., 140 to 1 ratio and 200 amp. per sq. ft. as if a solution containing 250 gm. per l. chromic acid were to be used at 130°F., 150 to 1. ratio and 300 amp. per sq. ft.

The proprietary crack-free chrome solutions which are available are based on these same principles of slightly modifying the conventional plating solutions so as to obtain these H.T.H.R. conditions. However, these crack-free chromium deposits are certainly not stress-free, in fact the tensile stress in them is still very high. Nevertheless the stress is much less than the value of about 200,000 lb. per sq. in. found in conventional chromium plate deposited at about 100°F. before this cracks. Once this thin chromium does crack then the stress drops sharply below the level of the crack-free deposit, as can be seen from Fig. 4 showing a graph taken from Fry's work.

In fact it has been claimed that the internal stress in a thick chromium deposit, as used for engineering purposes, is inversely proportional to the number of cracks in it. Fig. 5 taken from the paper by Stareck, Seyb and Tulumello[12], shows the relation found between the number of cracks per linear inch and the internal stress for 0.002 in. thick chromium plate produced under varying operating conditions. It has been clearly demonstrated that some chromium deposits having thicknesses of at least 0.001 in. can be obtained with compressive stress and this chromium plate is undoubtedly much more cracked than chrome that has a high tensile stress.

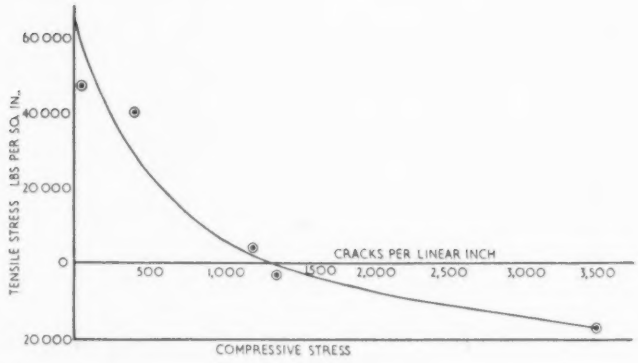


Fig. 5.—Stress in chromium deposits as a function of number of cracks in that deposit (thickness 0.002 in.) (Stareck et al[12]).

The addition of selenic acid in small quantities to conventional chromium plating solutions has been claimed[13] to reduce the stress in the chromium deposits and prevent cracking. Unfortunately the plate is dull and has poor covering power. Also the position is confused as the effect of selenic acid at slightly lower concentrations and lower plating temperatures is said[14] to give bright plate containing a multitude of cracks, which is a direct contradiction of the effects claimed in the previous patent.

Nickel Plus Chromium Coatings

Although spontaneous cracks are a sign that the tensile stress in a chromium deposit has decreased, they nevertheless are to be avoided, if possible, for they do constitute a danger to the underlying nickel. Firstly the stress, although it has been locally relieved in the chromium, is now concentrated at the base of the crack and so gives a notch effect in the nickel. If this nickel is already highly stressed, it could now fail and crack itself. Even if the nickel did not crack immediately it could well do so through stress corrosion, the portions of the nickel at the base of the cracks becoming anodic to the bulk of the deposit, with this attack being accelerated by the normal tendency of nickel to be anodic to chromium on atmospheric exposure. Therefore, even if cracks in the chromium do not immediately produce spontaneous cracking of the nickel beneath, they may do so later on in service. Even if the nickel does not crack, the crack pattern in the chromium may well be reproduced in the nickel by corrosive attack occurring through these cracks and of course once the nickel has been completely etched away, the basis metal itself will corrode.

Therefore, if the thicker coatings of chromium which have been shown to give such improved corrosion resistance are to be used, it is best to employ a crack-free chromium process to avoid the otherwise inevitable cracks which occur in the conventional chrome plate. However, for plating onto non-rigid articles which are likely to be bent during assembly or flexed in service, there is a case for using a type of chromium which already contains a very large number of cracks, for chromium deposits are so brittle that they crack with only small deflections. If many cracks are already present, the few extra cracks produced on bending will not make much difference, inasmuch as any corrosion will be distributed over a much larger area of previously bare nickel surface, rather than concentrated on a small area of freshly exposed nickel. There will also be a better distribution of stress relief and this will mean that any cracks that do propogate themselves into an underlying brittle nickel will do so to a lesser depth than if a conventional plate had been applied. This type of chromium plate, which contains so many cracks that individual ones can only be distinguished under the microscope, can be produced by using exactly the opposite conditions used for crack-free chromium — that is — low temperature, low ratio, low concentrations of chromic acid.

Another entirely different but nevertheless relevant manner in which subsequent chromium plating can effect a nickel deposit is that the chromium plating process will lower the ductility of the nickel by the mechanism of hydrogen embrittlement. It might be thought that sufficient hydrogen would be evolved during the deposition of the nickel to saturate this metal but this does not appear to be the case, as indicated by some results reported in 1957[15]. The ductility of a Watts nickel deposit was determined before and after chromium plating. The results were expressed in arbitrary, but reproducible and comparative units, as shown in Table V.

The chromium on the chrome plated test-pieces must have cracked as soon as the slightest elongation of the tensile test took place and while these cracks may have had a notching effect on the

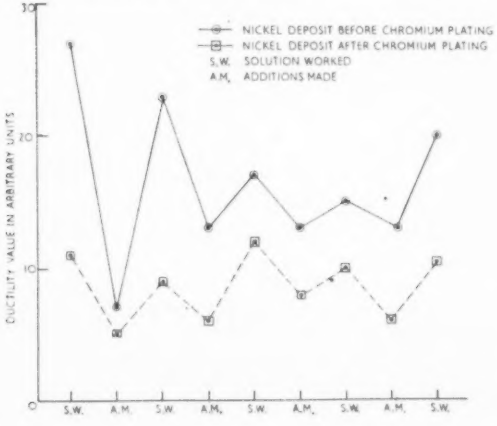
Table V

Hydrogen Embrittlement of Nickel Deposits

Type of Deposit	Ductility of dull Nickel in Arbitrary Units
(1) Nickel deposits before chromium plating	23
(2) Nickel deposits after chromium plating	10
(3) Nickel deposit after chromium plating but with chromium stripped off	12
(4) Nickel deposit after chromium plating but after heat treatment	24
(5) Nickel deposit after chromium plating followed by heat treatment and then chromium stripping	26
(6) Nickel deposit not chromium plated but made cathodic in an alkaline solution for 5 minutes	7

nickel below, there is not a great difference in the point at which the nickel cracked, whether or not the chromium had been removed by anodic dissolution in caustic soda. Stress relieving for one hour at 200°C. appeared to restore the full ductility of the Watts nickel, but it is by no means certain that the same would hold for an organic bright nickel. However it is certain that the ductility of a nickel after chromium plating does depend on its ductility before that operation. However it does not follow that a bare nickel plate which has double the ductility of another will still be twice as ductile after chroming, the ratio will then be lower. Nevertheless the trend is always for the most ductile nickel to be still the most ductile after plating with chromium ; Fig. 6 shows the variation in ductility obtained as an organic bright nickel solution is worked.

Fig. 6.—Variation in ductility of bright nickel deposits before and after chromium plating as the nickel solutions is worked (Such[15]).



To sum up, it is clear that internal stress in nickel and chromium deposits is of different significance in the effect is has on the likelihood of the underlying nickel cracking, when coatings of nickel plus chromium are being produced.

For nickel itself the position is simple ; as low a tensile stress as possible or even a compressive stress is needed. These conditions are provided automatically by the modern bright nickel solutions. However the more ductile a nickel deposit, the more the stress in it can be ignored, as for example with the dull plate from a Watts bath. The important thing to bear in mind when using a dull nickel bath is that many of the contaminating chemicals which lower the ductility of the plate also raise the stress and so have a doubly bad effect. To prevent this happening, both good house-keeping and regular solution purification are necessary, similar to that required to obtain the best results with bright nickels.

As far as the top-coat of chromium is concerned, the picture is not so clear. The plating conditions to be preferred are those which produce a deposit which has a high tensile stress and yet is uncracked, rather than one which actually has a lower stress but is cracked. Again this is not a point which need engage the attention of the average plater depositing the usual 0.00001 in. minimum or less, for this thin chromium plate will usually be uncracked, even if deposited at 100°F., especially if care is taken to avoid build-up on edges. The likelihood of thin chromium coats cracking will be even less if strong solutions containing about 500 gm. per l. of chromic acid are used. However, if thicker chromium coats are required to reduce porosity, then the crack-free type of conditions must be used and these produce a more and not a less stressed deposit. So while high tensile stress is prone to cause cracking in nickel deposits, the same argument does not necessarily apply to the layer of chromium applied over the nickel.

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Letters to the Editor

• Some Comments from the V.E.D.C.

SIR,
I find the arguments of "Platelayer" set out under the heading of "Misnomer" in your September issue bewildering, perhaps because they are based on apparently incorrect facts.

He starts be referring to "a recent failure of a prosecution against a paint manufacturer for allegedly describing a paint for bath tubs as a 'porcelain enamel'." What prosecution? The only one of which I am aware was that brought by the Board of Trade at Tower Bridge Magistrates Court on July 15, this year against a paint firm for selling paint to which a false trade description, namely "porcelain enamel," had been applied. The firm was convicted and fined £20 with £25 costs.

This case establishes that "porcelain enamel" should only be used to describe the application by a fused process, and has, we hope, checked the gradual encroachment of the paint manufacturers in regard to the use of terms which by rights belong to the porcelain- and vitreous-enamel industry. The fact that they do seek to borrow our terms is, of course, a fine compliment to our finish, but it is nevertheless obviously against the interests of the public to permit it.

When incorrect descriptions of products are allowed, incidents occur such as that quoted by "Platelayer" of the Sunday newspaper correspondent who stuck to the bottom of his or her bath after applying to it a paint which softened under the action of hot water. Unless trade descriptions are safeguarded, the public is misled.

In his final paragraph "Platelayer" gives it as his opinion that only marginal improvements in the technology of enamelling are likely. May I give it as my opinion that extensive and far-reaching developments are not only likely but are at this moment in fact taking place. Examples are the formulation of new and improved frits "direct application," *i.e.* one-coat enamelling, and numerous advances in production methods. Through these developments, and also on account of the fact that none of its competitors in the organic field possesses such a combination of valuable properties, true enamel has an ensured bright future.

I cannot refrain from expressing surprise that your publication which is the official organ of the Institute of Vitreous Enamellers sees fit to print such a passage as appeared under the heading "Misnomer." I have no knowledge of the skill of "Platelayer" at laying plates, but I now have some indication of his capacity for dropping bricks.

Yours, etc.,

GEOFFREY CLARKE

General Manager,
Vitreous Enamel Development Council,
London, W.1.

"Platelayer" clarifies his orginal statement on page 358—Ed.

• Consulting Scientists

Sir,
I have read with interest the article entitled "International Research Corporation Starts Operations in U.K." which appeared on page 315 of your August issue. The information contained in this article is very interesting, but may tend to give the impression that contract research and the allied matters referred to were unknown until recently in this country and in Europe generally.

The term "contract research" is usually taken to mean research carried out by a scientific contractor utilizing staff specifically for the purpose and reporting solely to the client. The project is treated completely confidentially as between contractor and client. This type of research was carried out in the United Kingdom in the 1930's, if not before, and some British laboratories have been greatly expanded for this type of work since the end of the last war.

In recent years the Association of Consulting Scientists, was founded to act as a representative association for independent consultants including those laboratories specializing in contract research. It is perfectly true that there is a need for much more research of this type within the British Commonwealth and if the activities of the American organizations result in an overall increase, this will be beneficial to all concerned. It should, however, always be remembered that British laboratories are available for contract research as well as the ordinary day-to-day run of consulting scientific work.

Yours etc.,

W. H. STEVENS.

Hon. Secretary,
The Association of Consulting Scientists,
Bromley, Kent.

The Second EFFLUENT and WATER-TREATMENT Exhibition

October 31 to November 3

A PREVIEW OF SOME EQUIPMENT ON SHOW

The second Effluent and Water Treatment Exhibition and Convention at the Seymour Hall, London, from October 31 until November 3 will be nearly twice the size of the one held in 1960. There will be a number of developments and innovations on show at the Exhibition and at the Convention papers will be presented covering internationally the subjects of Effluent and Water Treatment by well-known authors.

Increasingly severe restrictions are being imposed by River Authorities on the type of effluent discharged. The growing volume of water required for industry cannot always be provided economically from available sources and recovery of used water is of prime importance. Both the subjects are well represented at the exhibition by new designs and techniques. Some of these having particular interest for the metal-finishing industry, are reviewed in the following pages.

The British Drug Houses Ltd.
Stand No. 3

B.D.H. are already well-known for their extensive range of laboratory and fine chemicals for industry and in this exhibition they are devoting their display to the problem of slime growths in industrial water systems. The nature of these slimes is demonstrated and the special feature of the exhibit is the control of these slime growths by the use of Panacide, which is considered to be a considerable advance in the control of such growths whether they be due to bacteria, fungi or algae.

It is already widely used in cooling towers, condenser systems, air washing and conditioning plants and refrigeration plants to prevent growths which block pipes and jets and cut down heat exchange rates.

Up till now, it has sometimes been necessary to use a variety of chemicals to control different slime growths, but with its claimed remarkable activity against such a wide range of organisms, Panacide can be used to deal with any biological slimes.

The Candy Filter Co. Ltd.
Stand No. 30

A working model of the vertical flow sludge blanket-type reaction/sedimentation tank will be shown. This model demonstrates the manner in which flocculation and settlement is achieved in a tank of this type. The tank is constructed of Perspex materials and simulated a sludge blanket is maintained in suspension in the upward flow of water. Clear water is seen being decanted into the collecting channels bridging the top of the tank.

Another model, that of the Candy rapid gravity filter floor will also be on show. The reticulation system of a filter whether of the gravity or pressure type is the most important feature of it. The model clearly shows the design and construction of the Candy non-corrodible type-A floor and makes clear how the exceptionally even distribution of airscour and upwash is achieved and the media maintained in first-class condition throughout the entire life of the plant.

In addition an opacity recorder which measures colour, suspended matter or other impurities that may be expressed in these terms, in a stream of liquid, will be shown. This instrument can be of particular value where such impurities must not be present in excess of a set quantity and may then be used to sound an alarm, shut off a valve, or otherwise prevent the sub-standard liquid from passing to supply.

Cellulose Development Corporation Ltd.
Stand No. 35

The products which the company will be showing include a typical Celdecor-Egger centrifugal pump (Fig. 1) with unique impeller specially designed for the efficient handling of aerated or viscous liquids or liquids containing solids in suspension such as paper pulp, sewage, etc.

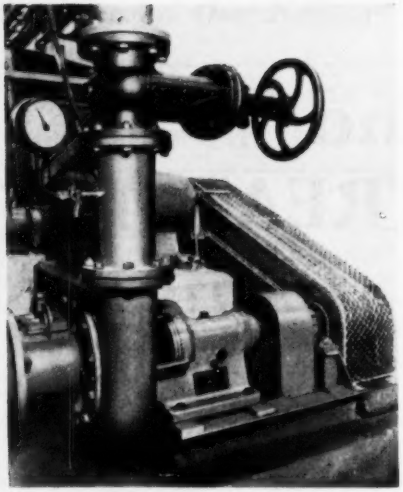

Fig. 1.—Typical Celdecor-Egger centrifugal pump, in action at Bowater's Sittingbourne factory.

On account of its design and performance this pump is being increasingly installed throughout the world. Its performance is based on the design of the patent impeller which by virtue of the shape of the blades and the divergence of the passages in the impeller, enables the speed of the liquid relative to the impeller to be considerably lower and also more uniform than in the conventional type of pump. The cross-sectional area of the outlets from the impeller may be as much as ten times that of the inlets (according to requirements). As a result there is a marked reduction in the friction between the liquid and the impeller surfaces and also in the internal friction in the liquids. This is important in the case of thick, viscous liquids, or liquids carrying solids in suspension.

Another advantage of the impeller is that owing to the shape and small number (usually 2 to 4) of the blades, the fluid, to attain the same speed, travels three times the distance it does in a similar conventional type of pump. This results in a lower acceleration of the liquid in attaining kinetic energy and a lower deceleration of the liquid during the conversion of the kinetic energy into pressure energy. Thus thick or viscous fluids have time to acquire a higher velocity and subsequently a higher pressure. The effect of this is that the performance in pumping a viscous liquid approximates to that of the same pump, pumping clean water.

Another claim for the Egger pump is the high suction lift which it can exert. Owing to the shape of the blades — and particularly the conformation of the tips of the blades — the liquid lags slightly behind the blades during rotation. This lag creates a decrease in pressure behind the blades which greatly increases the suction lift of the pump.

If the liquid being pumped contains gas, this collects continuously in this zone of low pressure, thus avoiding gaseous pockets forming inside the liquid, an occurrence which causes irregular functioning in the case of conventional centrifugal pumps. Again owing to the blade profile, the gas collected behind the blades is free to leave the impeller at the periphery, where it mixes uniformly with the liquid.

Another important effect of this separation of gas within the impeller is that, unlike a conventional centrifugal pump, an Egger pump will pump satisfactorily with air in the suction pipe. This remarkable characteristic can be utilized to maintain a constant level of liquid in a tank without any float or other moving parts.

A series of small holes is drilled at short vertical intervals in a vertical pipe in the liquid in the tank. If the pump draws more liquid out of the tank than is entering it, the level of the liquid will fall and expose more holes. The pump will then aspirate more air and its rate of withdrawal of the liquid will decrease, thus raising the level of the liquid In the tank. If the level rises, less air will be aspirated and the pump will remove more liquid thus lowering the level of the liquid in the tank.

Also being shown is an Egger iris diaphragm valve for accurate regulation and control of the flow of liquids especially those containing solids in suspension.

Coating Contractors Ltd.

Stand No. 31

Coating Contractors Ltd. apply on site and in their plant at Buckingham a wide range of high-build anti-corrosive coatings, both elastomeric and hard in type. The majority of these coatings are the "Adcora" range made by their parent company, E. and F. Richardson Ltd., and include Neoprene, Hypalone, Viton, Coal-tar Epoxy, Phenolic Epoxy, Solventless Epoxide, and Polyurethane formulations.

Both the coatings and the application service will be demonstrated by photographs and physical exhibits, showing the methods adopted for the protective coating of small and large bore pipework, valves, pumps, fans, ductwork, tanks, etc.

Of particular interest will be details of contracts carried out involving the blast cleaning and protective coating of 3½ miles of 9 ft. 6 in. diameter hydro-electric steel tunnels and penstocks, at the Ffestiniog pumped storage scheme and the Rheidol hydro-electric project, using Adcora A3 (SG) Coal-tar Epoxy ; the Neoprene-Adcora P.6 coating of the world's largest single unit sea water distillation

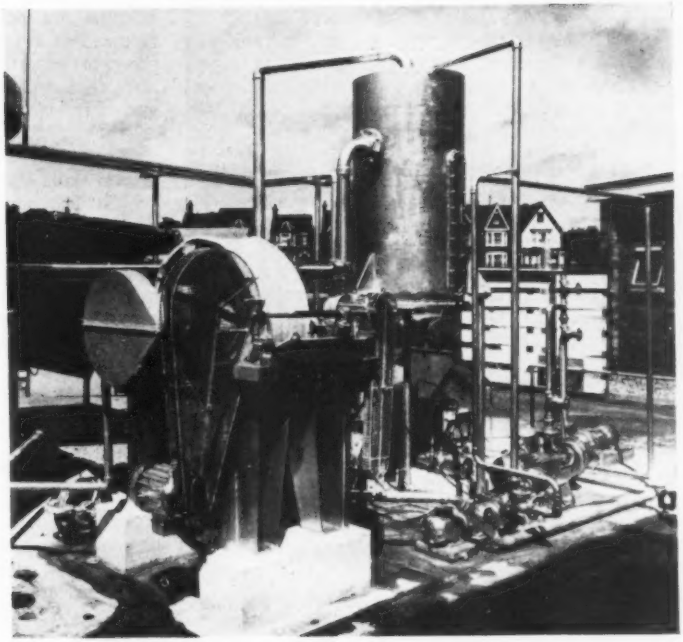

Fig. 2.—A 10-sq. ft. rotary vacuum filter, manufactured by Davey, Paxman and Co. Ltd.

plant, operating at temperatures ranging from 108° F. to 200° F. and vacuums varying from 28 in. Hg. to 7 in. Hg.; the coating of 1,800 spent fuel element cooling pond skips at Hinkley Point nuclear power station with Adcora SP Solventless Epoxide, which was selected by the contractors as being the most economical coating which would give the necessary protection and resistance to radiation and mechanical damage, and the protective coating of various items of water treatment equipment, including degasser towers, pipework, valves, filters, steel and concrete tanks for containing treated water and effluents.

Davey, Paxman and Co. Ltd.
Stand No. 19

Paxman are again featuring the sludge concentrator. Important strides have been made with this machine since the last exhibition and considerable field experience has been obtained proving its great advantage. This machine will again be featured by an animated display, giving a visual demonstration of the operation of the machine. In addition there will be a number of photographic displays of various applications of sludge concentrators and rotary vacuum filters (Fig. 2) for effluent and sewage disposal projects. A cut away model of a rotary vacuum filter will also be featured.

Considerable research work has taken place since the last exhibition on the use of the sludge concentrator in connection with primary sewage sludge, and a 12/1 machine has now been in service at the sewage works of Bletchley U.D.C. operating for some seven months, and we are indebted to Bletchley U.D.C. and the Council's Engineer and Surveyor, Mr. J. F. Smithie for the reference to this installation. Since filtration is very wide in its application it is felt that personal discussion can contribute more than exhibition models and therefore specialists will be in attendance on the stand to discuss user's problems and also to supply information on experience and performance in the field.

Evans Electroselenium Ltd.
Stand No. 7

The company will be showing a range of EEL instruments that have proved themselves valuable laboratory equipment for water and effluent analysis, and the following will be included :

EEL Absorptiometer. Designed to measure the colour density of liquids, this instrument is suited for water and effluent analysis and is used for the following determination : iron, nickel, zinc, manganese, chloride, copper, cyanide, silicon, ammonia, nitrite, nitrate, phosphate, chlorine, chromium, thiocyanate. It accommodates glass cells from 2.5 mm. to 100 mm. in length, offering a high degree of accuracy for the determination of low concentrations.

EEL Spectra. A newly introduced instrument for determinations as above, incorporating a continuous spectum wedge giving accurate determinations over the range 400 to 700 milli-microns, and a sliding carriage to accommodate cells containing both samples and reference blanks.

EEL Flame Photometer. Designed to determine alkalis in solution, this instrument is suited for the measurement of sodium and potassium in outfalls.

EEL Quantitrator. Of particular interest to those concerned with the determination of water hardness, for accurate determinations of end-points with calcium and combined calcium magnesium. This instrument can be used for titrations which involve the use of complexions.

EEL Sedimentometer. This instrument is designed for the determination of the size frequency of powders within the subsieve range.

International Combustion Products Ltd.
Stand No. 32

The company will be showing a range of products among which can be seen the Hardinge Thickener. A working model of this piece of equipment will be shown, in which gravitational settlement of solid particles is effectively carried out meeting the most stringent requirements for the recovery of clarified liquid and dewatered solids. It is available in a range of sizes for clarifying industrial effluents, automatically and continuously.

Dynocone Continuous Solid Bowl Centrifuge. Dynocones consist of a horizontal revolving shell or bowl, cylindrical and frustoconical, or frustoconical in form, inside which a screw conveyor of similar section rotates in the same direction at a slightly higher speed. With their flexibility in operation, these machines are used for the separation of solids from liquid suspensions and hydraulic classification. They are available in a range of sizes with capacities up to 25 tons per hour.

Rovac Filters. The smallest machine in the range of Rovac filters which are used for the continuous separation of solids from liquids. Successful installations are now operating on such varied applications as chemical, food, paper and mineral processing.

Vacseal Pumps. These pumps are used to handle all kinds of industrial slurries, including dirty water, sand and gravel slurries, and meet the most difficult and arduous pumping problems where abrasive solids are conveyed in suspension in corrosive liquors. Expandable pumping components are readily replaceable, and are manufactured in a variety of different materials to suit the particular duty. Available in a range of sizes with capacities from 5 to 3,500 gal. per min. and with vertical or horizontal spindles.

Raymond Flash Drying Systems. An animated display will show the method of operation of a typical Raymond Flash Drying System. These systems represent the modern method of drying damp, granular or fibrous material by circulation in a hot, turbulent gas stream. A disintegrator or pulverizer is incorporated in the system when simultaneous drying and grinding is required. Particularly suitable for drying materials such as wet coal cake and sewage sludge, and also for the preparation of chemicals, foods and fertilizers.

A. M. Lock and Co. Ltd.
Stand No. 45

A. M. Lock and Co. Ltd. will exhibit a representative range of instrumentation used in the analysis, monitoring and automatic control of the detoxication and neutralization of effluents and trade wastes.

One of the most important exhibits will be a miniature automatically controlled treatment plant for acids and alkalies including those containing cyanide and chromate. In the rapid reaction tanks, Lock cyanide, chromate and *p*H detector assemblies will continuously monitor the chemical reactions and through their associated electronic controllers automatically regulate the addition of the appropriate reagents to ensure complete and rapid detoxication and neutralization without an excess of reagent.

For flow rates up to approximately 2,000 gallons per hour, complete prefabricated automatically controlled treatment plants can be provided. For larger flow rates the various reaction and settling tanks would be constructed on site, the instrumentation only being packaged for immediate installation.

Important advantages claimed for these automatically controlled treatment plants include :—

1) great reduction in the size of plant required.
2) lower capital and operating costs.
3) reliable detoxication with varying toxic concentrations.
4) no overdosing ensures economical use of chemicals.
5) packaged prefabricated plants available.

Industrial Level Controls

A range of probe type and nucleonic type level controls will be exhibited as working demonstrations.

Laboratory Instruments

A range of laboratory instruments will be displayed and in many cases demonstrated and will include, conductivity bridges and cells, Pye range of laboratory *p*H meters, Lock/Ingold single-rod abrasion-resistant *p*H electrodes and an automatic water sampler.

Mono Pumps Ltd.

Stand No. 18

One of the most frequent problems associated with trade effluent is that of spent plating solutions, which must be neutralized before discharge into sewers. The company will display a range of their pumps suitable for handling spent plating solutions and for dealing with neutralized effluent both in liquor and sludge state.

The company claims many features of the Mono Pump as ideal for use on effluent treatment plants. It can prime itself without the aid of separate priming devices on suction lifts up to 25 feet of water. With its powerful suction ability there is no need to prepare a separate pit to obtain a positive head, or submerge the pump in the untreated liquor. Foot-valves are unnecessary. The suction power is of special value when drawing liquor from expensive corrosion resisting vessels, as there is no need to cut bottom outlets. As shown by a quarter sectionalized model on the stand, it is a simple mechanism, easily maintained, and its smooth running has advantages for automatic stop/start duties. From the standard types of pump available an infinite range of capacity can be obtained from 30 to 8000 gallons per hour with pressures up to 130 pounds per square inch.

One of the latest developments in pumping is that of conveying powders through pipelines. On the stand, the powder pumping division will be showing the P12 (Fig. 3) and the Junior Moon powder pump, which can be usefully applied to duties where lime or other powdered re-agents are necessary for effluent and water treatment. The technique of injecting air into the powder to form fluidization is employed, so that the powder behaves in a similar way to fluid along a horizontal or up a vertical pipeline. When used in conjunction with the Mono hoverslide fluidizing base, only small quantities of air are required for fluidizing powder and the Mono powder pumping system is therefore ideal for automatic control of metered dosing. Outputs from 5 pounds to 80 hundredweight per hour can be obtained from the pumps displayed. The Junior Mono powder pump will be demonstrated as a working unit on the stand.

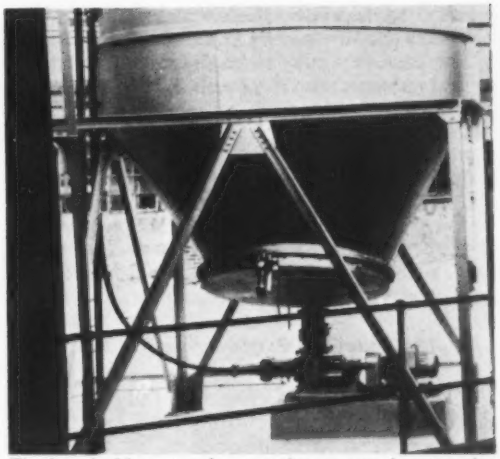

Fig. 3.—A Mono powder pumping system incorporating both the P12 powder pump and "Hoverslide" fluidizing base, fitted to a 20-ton storage hopper for pumping a powdered line re-agent to treatment tanks on an acid effluent plant.

Neldco Processes Ltd.

Stand No. 34

The company will be showing the Clarkson valve type "J" (Fig. 4) which consists simply of an alloy casting into which is fitted a specially designed rubber sleeve. The valve is operated by low pressure air, 30 lb. per sq. in. being

Fig. 4.—The Neldco Clarkson type 'J' valve showing alloy casting and rubber sleeve.

required to close it completely and the aperture is similar to that of a normal pinch valve.

The Clarkson valve is ideally suited for remote control and operation from instruments. Standard and inexpensive control equipment is adequate and the installed cost of an automatically controlled Clarkson valve is claimed to be substantially lower than that of any other type of valve. At present this new design is available in sizes from 2 in. to 10 in. with flanges to B.S. Table D. Neldco will also be demonstrating their Sala valves, which have a completely round aperture and some of their range of metering devices.

The Paterson Engineering Co. Ltd.
Stand No. 43

The Paterson Engineering Co. Ltd., and associated companies will be exhibiting a selection of plant for filtration and treatment of water and effluents with particular emphasis on recent developments in the automation of these processes.

Exhibits will include an automatic filter control table together with a mimic diagram and special working models of the accelator and the effluent accelator constructed of transparent material to show the interior parts in action.

A novel luminescent device will demonstrate by means of animated flow diagrams the successive steps in the operation of the rapid gravity filter, the Stellar filter and the accelator. Models of the Stellar diatomaceous earth filter will also be on view.

Chlorination and sterilization will be represented by various types of the CE Chlorinator and by a recent successful addition, the BM residual chlorine recorder. Several types of the Clorocel, which produces electrolytic sodium hypochlorite from a solution of common salt or from sea-water will also be shown.

Coloured transparencies will be used to illustrate some of the more important water-treatment plants which the company have installed in recent years.

Plastic Coatings Ltd.
Stand No. 23

Plastic Coatings Ltd., will be showing their most recent systems of dip lining and coating pipework etc., (Fig. 5), for which the company claim economies over previous rubber lining methods. This method of lining has been generally well received throughout the industry as it not only gives a highly anti-corrosive internal treatment to pipework but reduces many of the metal flanges previously necessary in rubber lining and at the same time the external coating obviates further maintenance.

The company also manufacture small P.V.C. caps which can be pushed over the top of threaded bolts to prevent paint over-spray from contaminating them. These caps are designed to be an easy push fit and are solvent resistant. Their use illiminates time-consuming masking or re-tapping processes after paint dipping.

Fig. 5.—Large plating jigs corrosion proofed by P.V.C. dipping using plant manufactured by Plastic Coatings Ltd. The plant can handle work up to 5 tons in weight.

Prodorite Ltd.
Stand Nos. 26 *and* 27

Prodorite Ltd., offer a complete service to industry including design, installation and commissioning of effluent treatment plant. This covers chemical engineering and acid proof construction of all types including tanks, floors and drainage embodying a range of corrosion resisting mastics, compounds and a new and improved range of cements manufactured in this country by the company under special licence from Farbwerke Hoechst A.G., these being covered by world patents.

A wide range of materials is available for use by firms wishing to carry out their own installations and maintenance for which technical service and advice is available.

Anti-corrosive surface coatings feature Prodor-film tank and pipe linings, Prodor-Glas and Prodorcote synthetic linings and coatings for protection against beer, fruit-juices, milk, edible and crude oils, diesel, petroleum and high octane fuels, while liquid and sheet Neoprene linings and coatings provide complete anti-corrosive, anti-abrasive and weather proofing protection for a wide range of plant and equipment.

Plastic fabrications and piping installations in P.V.C. and Polythene are supplemented by a range

of resin/glass laminate materials with the trade name of Orglas, these materials are resistant to practically all oxidizing and non-oxidizing acids, alkalis and solvents, up to temperatures of 120°C ; Orglas Y50 is available for temperatures up to 160°C.

Saunders Valve Co. Ltd.
Stand No. 21

Continuous development having taken place since the last exhibition, some of the Saunders products first seen in 1960 will be shown in greater variety. The emphasis is on the use of a wider range of body materials and linings, together with greater expansion in diaphragm production and development.

Since the body and diaphragm are the only two components of the Saunders valve which are in contact with the pipeline contents, the choice of the correct materials allows virtually all fluids to be controlled with leak-tight precision.

Recently introduced items include diaphragms grade 226 permitting slurries involving aromatic chemicals to be handled by the type KB straight-through valve. On show will be a silver-lined body having particular resistance to chlorine. New valves in rigid PVC., produced to match similar pipework, can control acids, alkalis and oils. Of interest are valve bodies lined with Penton, a smooth thermoplastic having a very favourable combination of high temperature and high chemical resistance. Titanium-lined valves can be examined.

These special coatings are additional to linings and diaphragms of rubber and plastics, of which several examples are exhibited.

Centrifugal pumps produced by the Safran Pump Division are displayed, as well as a selection of plug valves for industrial uses made at the company's aircraft division.

Simon-Carves Ltd.
Stand Nos. 1 *and* 2

The Simon-Carves Monsanto effluent advisory service will be demonstrated. The service was jointly established by Simon-Carves Ltd. and Monsanto Chemicals Ltd., in 1960 and was demonstrated at the first Effluent & Water Treatment Exhibition that year. Both companies have wide experience of the purification of industrial wastes, Simon-Carves as chemical engineers and contractors and Monsanto Chemicals as chemical manufacturers. The advisory service makes their combined scientific knowledge and research facilities available to industry, local authorities and others in dealing with problems of effluent treatment and disposal.

The service embraces investigation of particular effluent problems, recommendations for treatment processes and plant design, and advice on plant operation. It is backed by the engineering and contracting organization of Simon Carves for the construction and installation of complete effluent treatment plants.

The display at the exhibition will include working exhibits and a continuous slide projector with commentary describing the advisory service ; technical representatives will be available to deal with enquiries.

Since the service was first announced, a large number of enquiries have been received from River Boards, Water Boards, Public sewage undertakings and a wide range of industries.

The Tintometer Ltd.
Stand No. 24

The Lovibond comparator and the B.D.H. Lovibond nesslerizer are used throughout the world for the control of the purity of all types of water, and the manufacturers of this equipment will be exhibiting a range of Lovibond Comparator kits specially designed for testing water in swimming pools, rivers, effluents, boiler feed, drinking water, etc. The B.D.H. Lovibond nesslerizer is also being exhibited together with a range of discs of permanent glass colour standards.

Some of the tests for which permanent glass colour standards are available for use in the Lovibond comparator and the B.D.H. Lovibond nesslerizer are aluminium, ammonia, chlorine (range from 0.01 to 250 p.p.m.) copper, iron, lead, manganese, nitrate, nitrite, oxygen, *p*H (range from 0.2 to 14.0), phosphate.

Of particular interest to chemists, and also those responsible for routine analysis, will be the book entitled " Colorimetric Chemical Analytical Methods " which will be available at the stand for inspection. This book which contains full procedures for well over 160 analytical tests, is a complete guide to well tried and reliable colorimetric analytical tests.

Transkem Pumps Ltd.
Stand No. 55

Transkem Pumps Ltd., will be showing a range of pumps on their stand. The complexity and wide varieties of chemicals and acids encountered during the treatment of trade effluent call for careful selection in the use of equipment to handle the various liquors, and for this reason Transkem pumps are lined with Petrox ' C,' a new, strong and dense industrial porcelain which has very high mechanical strength, and high resistance to thermal shock. It is unaffected by corrosive liquors and the reagents used in water treatment.

All the rotating parts of the TK pump can be easily withdrawn for examination or replacement

(*Continued in page* 386)

The Effluent and Water-Treatment Exhibition

(*Continued from page* 385)

without disturbing the pipe-line connections. While the one-piece volute casing remains on the bedplate, the rear casing complete with impeller, shaft and bearings can be withdrawn and swung round giving complete accessibility.

Transkem's designers have taken unit standardization to a high degree to give easy maintenance and to reduce the number of spares to be carried. Mechanical parts are interchangeable.

Pumps for duties up to 300 galls. per min. with heads up to 174 ft. are available. Open type impellers facilitate the handling of slurries and solids in suspension, making these pumps especially suited for handling effluents.

Wallace and Tiernan Ltd.

Stand Nos. 15 *and* 16

The company will feature chemical control equipment, three units of which will be a chlorinator, weigh-belt feeder and a volumetric feeder.

The V-notch Chlorinator:

The V-Notch Chlorinator features a unique idea in chlorine flow control, the V-Notch variable-orifice. Here, the flow of gas is altered by adjusting the position of a grooved plug within a fixed orifice producing a wide flow range according to the variation in area of the V-shaped orifice. The instrument is adaptable to manual or automatic operation and the addition of suitable auxilary devices enables operation to be carried out on a programme basis.

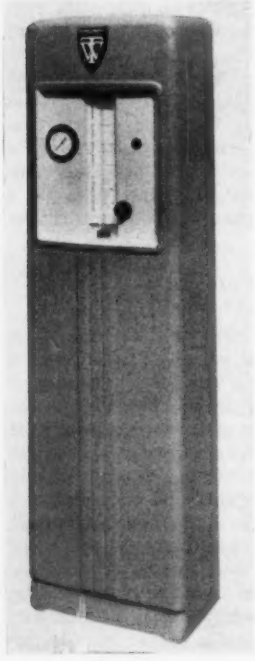

Fig. 6.—*The V-Notch Chlorinator incorporating the V-Notch variable-orifice, manufactured by Wallace and Tiernan Ltd.*

This modern conception in chlorinator design has proved highly successful in the treatment of water supplies, effluents and trade wastes as apart from the new principle in control, construction throughout is of the latest corrosion-resistant materials.

The Merchen Scale (Weigh-Belt) Feeder :

The Merchen Scale Feeder meets the need for precise handling and feeding of many diverse types of dry, ground and free-flowing materials. Its totally enclosed construction makes it ideal for handling dangerous, or easily contaminated commodities. Costly chemicals can be fed in streams into a mix with undeviating accuracy, reducing chemical handling to a minimum. Over any point of a 10 to 1 control range, the feeder has an accuracy rather better than plus or minus 1 per cent.

Material entering the feed section from above falls on to a supported weigh-belt, is carried under a flow-controlling gate and then over a section where the weigh-belt is counter-balanced by a pre-set weight on a scale beam. All the material fed is weighed, the continuous action of the gate being dependent on impulses from the weighing mechanism to increase or decrease the flow.

The Dry Volumetric Feeder:

The problem of handling certain " hard-to-feed" materials such as zinc oxide and diatomaceous earth has led to the development of the Dry Chemical Feeder. Volumetric in principle, it will feed free-flowing chemicals in powder or granular form with controlled accuracy.

International Galvanizing Conference

(*Continued from page* 370)

was perhaps not that normally used for quenching zinc may have had some influence — if not a decisive influence — on the ultimate result.

With regard to the concentration and immersion period for nitric acid, here nitric acid was of high concentration, and it was warm and the pickling was carried on over a sufficient length of time so as to be able to get proper findings.

" Beard formation " first arose when certain tests were made on steel sheets and it was found that they had a heavy coating on the rim and very much less in the centre. When photographs were taken they had the impression of " beard formation." This was a well-known structure, on silicon types of sheets, where the speed of the iron-zinc action was rapid. When the time was doubled one got a corresponding reaction. The essential point was that it was a relatively thick crystal conglomorate but between the layers there was zinc which remained adhesive even in the zinc bath, and this structure showed certain properties, and above all, in the case of the sheet where there was a silicon content there was relatively high, sur risingly high, adhesion.

(*To be continued*)

NICKEL PLATING - FOUR A & W ADVANCES

WHATEVER YOUR NICKEL PLATING PROBLEMS—A & W HAVE AN ANSWER THAT'S RIGHT FOR YOU!

PLUSBRITE NICKEL plating bath. Combines the seven major requirements for effective bright nickel deposits.

☐ Low costs ☐ Fully bright deposits of excellent colour ☐ Excellent levelling properties ☐ High ductility ☐ Good receptivity to chromium plating ☐ Rapid plating ☐ Easy control

SBSF—for semi-bright nickel plating at high speed, a stable, sulphur-free addition agent which gives the bath very good levelling characteristics. This semi-bright deposit is intended for use with Plusbrite nickel and is part of an excellent duplex system.

It is also useful as a fast-plating, semi-bright solution.

PLUSBRITE DUPLEX—is for use where excellent corrosion resistance and maximum ductility is required with a fully bright finish.

The addition agents do not produce harmful breakdown products and are not removed by continuous filtration through carbon.

NICKEL SULPHAMATE—provides a bath for rapid plating of heavy nickel deposits, with superior ductility and low internal stress. It is used in the production of gramophone record stampers, in electroforming, in the re-sizing of worn parts and in facing of stereos and electrotypes.

TURN PAGE FOR IMPORTANT NEWS ABOUT COPPER PLATING

The Effluent and Water-Treatment Exhibition

(*Continued from page* 385)

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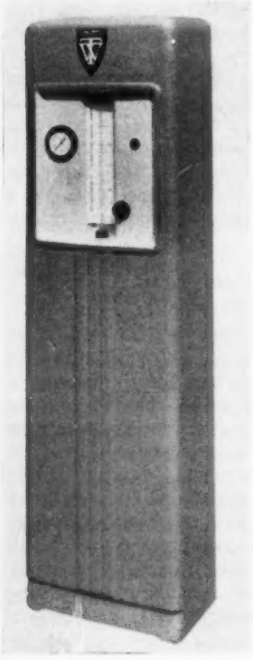

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International Galvanizing Conference

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(*To be continued*)

METAL FINISHING FROM A TO Z

NICKEL PLATING - FOUR A & W ADVANCES

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TURN PAGE FOR IMPORTANT NEWS ABOUT COPPER PLATING

COPPER PLATING - OUTSTANDING NEW PROCESS DEVELOPED BY A&W

PYROBRITE BATH WITH PY-61C MAKES FINISHING UNNECESSARY!

The new PYROBRITE bath with addition agent PY-61C was developed by Albright & Wilson's own chemists. It is a significant advance over all previous copper-plating methods, and has been proved in commercial practice □ Albright & Wilson's PYROBRITE bath, based on pyrophosphates, is less toxic than conventional cyanide baths and much higher plating rates are possible. It has outstandingly good levelling characteristics, is easy to control and produces fully bright, close-grained, smooth deposits which will not fingermark or spot out □ The PYROBRITE copper bath is used for decorative plating, particularly as an undercoat on steel and zinc alloy diecastings before nickel and chromium plating, and for electroforming.

METAL FINISHING FROM A TO Z

SILVER AND TIN PLATING - A & W LEAD THE FIELD

FOR SILVER PLATING—Plusbrite Silver addition agents give first class results for: ☐ Plating of electrical and electronic components. The deposit is unalloyed, retaining its full electrical conductivity ☐ Plating of decorative silver, tableware, cutlery, jewellery and musical instruments ☐ Plating engine bearings where minimum lubrication is available.

The Plusbrite silver plating bath provides: ☐ A fully bright deposit over an extremely wide current density range ☐ The possibility of very high plating rates ☐ A hard (110 V.P.N.) and tarnish resistant deposit ☐ Elimination of finishing in many cases.

FOR TIN PLATING—Albright & Wilson are now able to offer potassium stannate at an economical price. The potassium bath has the following advantages over the conventional sodium bath:

FOR ELECTROTINNING ☐ Higher plating speeds ☐ Less sludge ☐ Further improvements by using "High Speed" tin anodes.

FOR IMMERSION DEPOSITION ☐ Reduced sludge formation ☐ In the Phostin process for aluminium the solution composition is modified to provide a self-regulating bath requiring infrequent discarding.

NEWS ABOUT PLANT FOR PLATING AND POLISHING OVERLEAF

METAL FINISHING FROM A TO Z

ALBRIGHT & WILSON SUPPLY AUTOMATIC & MANUAL PLANT

Albright & Wilson design and supply automatic as well as manual plant for electroplating and chemical polishing. The resources of Albright & Wilson make it possible to meet specific as well as general orders for process and plant. Albright & Wilson have built the first automatic plant to be installed in the U.K. for the chemical polishing and anodizing of aluminium.

PREPARATION PROBLEMS SOLVED! Albright & Wilson offer these solutions: ☐ PHOSBRITE 183 chemical polishing solution effectively and quickly provides the essential level surface on brass before bright nickel plating, even with the most intricately shaped pressings. ☐ PHOSBRITE 184 similarly acts as a chemical polishing pre-treatment before bright silver plating on nickel silver or beryllium copper. ☐ PYROBRITE—the new copper-plating bath—provides a bright level deposit, eliminating copper finishing on zinc alloy diecastings and steel pressings before bright nickel and chromium plating.

OTHER PRODUCTS Special formulations for cleaners have been devised and are available for use with A & W metal finishing processes. Special grades of activated carbon and filter aid are available for use in the purification of plating solutions.

WHATEVER THE PROBLEM plating, polishing or plant consult ALBRIGHT & WILSON

ALBRIGHT & WILSON (Mfg) LTD Metal Finishing Dept. 1 Knightsbridge Green, London S.W.1 Tel: KENsington 3422

FINISHING NEWS REVIEW

DEPOSITION OF PRECIOUS METALS BY CHEMICAL DISPLACEMENT

NEW PROCESS NOW AVAILABLE

THE process for the deposition of platinum, rhodium, palladium and rhuthenium by chemical displacement, developed by The International Nickel Co. (Mond) Ltd., is now commercially available.

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METAL FINISHING FROM A TO Z

IRREGULAR

PAGINATION

FINISHING NEWS REVIEW

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ALBRIGHT & WILSON SUPPLY AUTOMATIC & MANUAL PLANT

Albright & Wilson design and supply automatic as well as manual plant for electroplating and chemical polishing. The resources of Albright & Wilson make it possible to meet specific as well as general orders for process and plant. Albright & Wilson have built the first automatic plant to be installed in the U.K. for the chemical polishing and anodizing of aluminium.

PREPARATION PROBLEMS SOLVED! Albright & Wilson offer these solutions: ☐ PHOSBRITE 183 chemical polishing solution effectively and quickly provides the essential level surface on brass before bright nickel plating, even with the most intricately shaped pressings. ☐ PHOSBRITE 184 similarly acts as a chemical polishing pre-treatment before bright silver plating on nickel silver or beryllium copper. ☐ PYROBRITE—the new copper-plating bath—provides a bright level deposit, eliminating copper finishing on zinc alloy diecastings and steel pressings before bright nickel and chromium plating.

OTHER PRODUCTS Special formulations for cleaners have been devised and are available for use with A & W metal finishing processes. Special grades of activated carbon and filter aid are available for use in the purification of plating solutions.

WHATEVER THE PROBLEM plating, polishing or plant consult ALBRIGHT & WILSON

ALBRIGHT & WILSON (Mfg) LTD Metal Finishing Dept. 1 Knightsbridge Green, London S.W.1 Tel: KENsington 3422

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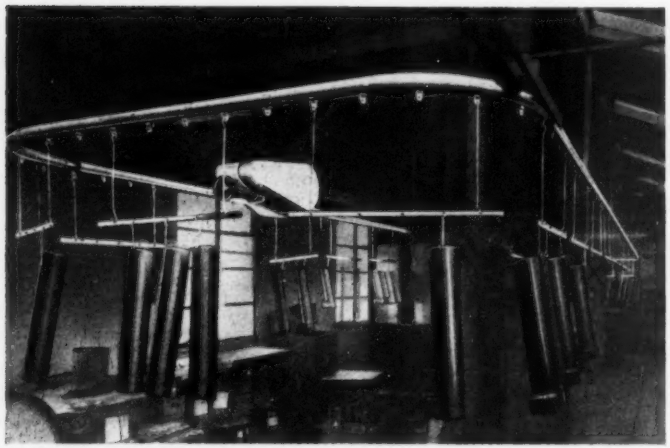


SHOWN above is a CHAINVEYOR installation manufactured by T. and T. Works Ltd., and installed at Heating Elements Ltd., Leicester. Painted articles are hooked on to the circuit at the right of the photograph and passed round through an infra-red drying oven emerging from the aluminium baffles at centre background. Tension and driving gear are also clearly seen. Installations of this kind may be rapidly made, due to the simplicity of the equipment and the ease with which it can be suspended from suitable roof structures or special floor stands. Customers with good mechanical or maintenance departments can carry out their own installations, as was done in this case by Heating Elements Ltd.

Antimony-Clad "Nilo-K"

JOHNSON Matthey can now offer to manufacturers of semi-conductor devices sample quantities of "Nilo K" strip clad on each side with 0.5 per cent gold-antimony. It is hoped that production quantities will be available early next year.

The strip is available in widths between 3/32 in. (2.4 mm) and 2 in. (50.8 mm), in thicknesses down to 0.005 in. (0.13 mm). The thickness of cladding that can be supplied on each face is either 11.5 per cent or 18.75 per cent of the total thickness.

New Plessey Factory at Swindon

THE Plessey Co. Ltd., announces the conclusion of negotiations to lease from the Swindon Corporation a further 50,000 sq. ft. factory at Cheney Manor, Swindon.

The factory, which is close to the existing Plessey factory group at Cheney Manor, is expected to be used for expansion of the company's Industrial Hydraulics Division. It will be recalled that in April of this year Plessey completed licence agreements with Guldner-Motoren-Werke for the production in this country of Guldner Hydro-Stabil hydraulic equipment.

ANTI-RUST TREATMENT FOR SCAMMELL TRAILERS

A NEW plant for protecting trailer parts against rust has just been put into operation at the Moor Park factory of Scammell Lorries Ltd., Watford.

The pre-treatment plant is operated by the dip method. Ramps, mudguards, frame crossmembers, wheels and other trailer parts are placed in a cage and carried by an electrically operated overhead hoist to the seven processing tanks.

In the first tank, parts are degreased by immersion in an alkali solution; then follows a cold rinse, immersion in a de-rusting tank where old rust is removed, another rinse, and immersion in a phosphate tank where they obtain a rust-resisting surface by the chemical reaction between the phosphating solution and the metal. Finally, parts are cold- and hot-rinsed and passed into the drying oven.

The plant will treat six tons of ferrous metal parts per hour, giving a dip rate of one ton every eight minutes.

On leaving the drying oven the treated metal parts are taken to Scammell's new wash-back-type spray booth for immediate painting. Some non-ferrous parts which are not painted, are immersed in oil tanks.

"ADVENTURE CENTRE" for YOUTH

SIR John Hunt, Director, Duke of Edinburgh's Award, recently opened the new "Adventure Centre" at Pont-y-Pant, near Betws-y-Coed, Wales, established by Tube Investments for its young employees of both sexes.

The first of its kind started by a company, the Centre consists of a country mansion set in its own estate, from where mixed parties will be introduced, summer and winter, to mountain activities and skills of living in the open, etc. — the girls being expected to share equally in all the arduous exercises with the boys.

The enthusiasm of TI's young employees over the Centre has been such that, since early Spring, large contingents of them have volunteered their week-end services in preparing the mansion for its new purposes—including the laying of new drainage, installation of central heating, and complete redecoration.

PVC Coating Cuts Maintenance Costs in Chemical Works

F. W. BERK and Co. Ltd., chemical manufacturers, recently installed a new sulphuric acid plant at their Stratford, London, factory. To meet the requirements of the Clean Air Act, it was necessary to build the metal chimney of this plant to a height of 150 ft.

The maintenance engineering staff wished to avoid the heavy cost of periodic painting and the possible early replacement of upper sections exposed to acid dewpoint conditions. They decided to protect the chimney with a coating based on Geon PVC.

Coating was carried out by Plastic Coatings Ltd., Guildford. Sections of the 2 ft. 6 in. dia. chimney were immersed in a tank containing a paste based on Geon 121 resin, thus coating both sides and flanges. When gelled, the paste forms a smooth abrasion-resistant coat with excellent adhesion to the metal. The coat is not affected by weather and requires no form of maintenance, and being corrosion-resistant, it protects the interior of the chimney from the acidic conditions of the plant.

In all 100 ft. of chimney were coated (the entire height above factory roof level), and at a recent inspection the effectiveness of the coating was already apparent.

Geon 121 PVC paste resin is manufactured by British Geon Ltd. a company in Distillers Plastics Group.

Painting of Plating Shops

MORGANITE Resistors of Jarrow are justifiably proud of their electroplating shop. In keeping with the remainder of their factory, attention has been paid to "good housekeeping." The floor of the shop is of acid-resisting brick while the walls are half tiled to facilitate cleaning. To combat corrosion of the steel deck roofing, the shop has been fitted with a false ceiling. The clean and efficient effect of the shop was, however, marred by the rather dilapidated appearance of some of the process tanks.

These tanks, all containing corrosive liquors essential in the plating processes carried out, were painted at frequent intervals. Unfortunately, however, the paints used did not withstand the wear and tear to which they were subjected.

In conjunction with Camrex Paints Ltd. (Industrial Division) tests were carried out to find suitable coatings to withstand the conditions prevailing in the shop. The tank selected for test was the mild-steel tank containing swill water which follows the 50 per cent HCl pickle. As there was considerable drag-out from the pickle tank the coating was subject to continuous acid attack. Paint life was a matter of weeks.

The tank was taken out of service, shot-blasted and treated with four coats of Camkote Grade "A."

After six months' service the coating is in excellent condition retaining its original colour and gloss. At one spot on the inside where there is a break due to mechanical damage from a basket of "work" the break has been confined to the limits of the original mechanical damage.

Further tanks are to be treated.

NEW STOKES SUBSIDARY IN LONDON

F. J. STOKES Ltd., the new British subsidiary of F. J. Stokes Corporation of Philadelphia, manufacturers of automatic compression moulding machines for the plastics industry, will operate from their head office at Mercury House, Hanger Green, Ealing, London, W.5. (Tel. ALPerton 2026).

General manager of the British subsidiary is James T. Davies, an Englishman, and a former sales engineering executive of the American parent company, who has returned to London and will be responsible for production, sales, and technical advice throughout the U.K.

AEI TRANSFER CABLE BUSINESS

ASSOCIATED Electrical Industries Ltd., and Enfield Cables Ltd., have now transferred all their business in paper-insulated and polythene-insulated telephone cables, and in co-axial and other high grade cables for telecommunications to Telephone Cables Ltd., Chequers Lane, Dagenham, Essex. Telephone Cables Ltd., formed in January this year and jointly owned by AEI and Enfield Cables, is now handling all home and export business in this field for both companies.

At Dagenham this company claims to have the most modern telephone cable production unit in the United Kingdom. It is the largest supplier of telephone cables to the British Post Office, for whom it also carries out extensive trunk cable installations. A large staff of experienced engineers can advise on cable requirements, assist in the design of cable networks, and carry out or supervise telephone cable installation anywhere in the world.

Ambulance Facilities in Factories

DRAFT regulations published by the Ministry of Labour require occupiers of certain factories and other premises in Great Britain to nominate a responsible person to be always available during working hours to summon an ambulance.

The premises to which these regulations apply are blast-furnaces, copper mills, iron mills and foundries, metal works, saw mills and factories in which articles of wood are manufactured in any of which 500 or more persons are employed, and all chemical works.

They replace a requirement under the Factories Act, 1937, that occupiers of factories shall provide and maintain an ambulance unless they have made arrangements for one to be obtained.

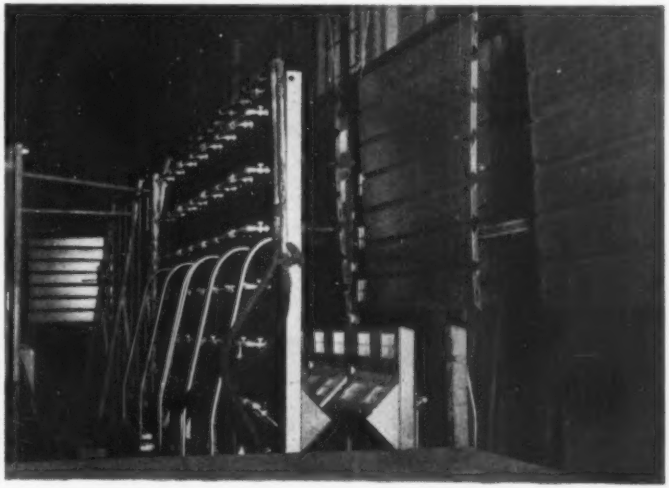
The Draft Blast Furnace and Saw Mills Ambulance (Amendment) Regulations, 1961 and the Draft Chemical Works Ambulance (Amendment) Regulations, 1961 are obtainable from H.M. Stationery Office, price 3d. and 2d. net respectively.

INFRA RED GAS OVEN CUTS HANDLING COSTS

THE illustration shows pressed panels leaving the infra red gas oven supplied by Parkinson Cowan Industrial Products, (of Cottage Lane Works, City Road, London, E.C.1.) to Edward Curran Engineering Ltd., Cardiff.

The panels, which are made of 16 swg. steel, pass through the 20 ft. long oven at the rate of 2½ ft. per min. for grease burning prior to pickling and vitreous enamelling. Gas consumption of the 92 Parkinson Schwank gas radiant burners involved is about 24 therms per hour — a running cost of about 28/- per hour.

As a result of installing the P.C.I.P. oven, Edward Curran Engineering Ltd. have saved both time and money by having all cleaning operations on a completely continuous cycle with no intermediate handling.



Latest Developments in PLANT, PROCESSES AND EQUIPMENT

All-PTFE Pump and Coupler

ONE of the foremost processers of PTFE (Polytetrafluoroethylene) in the country, Associated Electrical Industries Ltd., have now produced a pump, whose working parts are composed entirely of this plastic, and a coupler for PTFE tubing.

Chemical inertness and imperviousness to corrosive action are important properties of PTFE, and the pump will be particularly useful for corrosive fluids, or liquids which must be protected from contaminating influences.

The pump is a diaphragm type and is self-priming. The vacuum-formed diaphragm and all the other PTFE parts in contact with the liquid being pumped are housed in a cast aluminium body which is bolted directly to a capacitor-run a.c. geared motor. The gearbox provides a 7:1 step-down to give a diaphragm reciprocation speed of 200 cycles per min. Life of the diaphragm is more than 1,000 hours.

Pump delivery at a 1-ft. head is 2 litres per min., and at the maximum working head of 15-ft. is 1.25 litres per min. Power consumption is 50 watts. Overall dimensions of motor and pump: length 10 in., width 5 in., height 5 in. Three models are available, to operate from 100/110, 200/220 and 230/250 volts 50 cps a.c. supplies. Inlet and outlet ports of the pump are supplied "belled" to accept the new $\frac{3}{8}$-in. AEI PTFE pipe coupling.

The new coupler is a spring-loaded telescopic unit which expands to grip the tubing inserted at each of its ends. It enables PTFE tubing to be joined so that only PTFE is exposed to fluids travelling in the tubes.

The coupler, when used with tubing whose ends have been "belled," causes no restriction in the flow system; it is neat and easy to assemble and is capable of withstanding pressures up to 50-lb. per sq. in., even at elevated temperatures (*e.g.* 100°C.). It is made in five sizes from $\frac{3}{8}$ in. dia. to $\frac{7}{8}$ in. in $\frac{1}{8}$ in. steps.

A simple tool for "belling" the ends of the pipes can be supplied.

Pump and coupler are made and marketed by Fluorocarbons Section of AEI Radio and Electronic Components Division, 155 Charing Cross Road, London, W.C.2.

Drying Cabinet

A NEW standard hot-air drying cabinet (Fig. 1) has been introduced among the range of stoving, pre-heating and drying ovens manufactured by A. E. Griffiths (Smethwick) Ltd., Booth Street, Handsworth, Birmingham 21.

The unit is designed for drying off light components after plating, phosphating or similar processing operations.

Electrically heated with a rating of 10 kW., and suitable for wiring into a 400/440 volts, 50 cycle, 3 phase a.c. supply, the unit is thermostatically controlled for an operating temperature of 180/200° F., and the complete electrical switchgear incorporates a motor starter, fuse board, contactor and main isolation switch fuse unit.

Dimensions of the cabinet are 5 ft. 11 in. high by 3 ft. 6 in. wide by 2 ft. 6 in. front to back,

(*Continued in page* 396)

Fig. 1.—*Drying cabinet.*

Classified Advertisements

Prepaid rates: FIFTEEN WORDS for 7s 6d. (minimum charge) and 4d. per word thereafter, or 24s. per inch. Box number 2s. 6d. including postage of replies.

SITUATIONS VACANT

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Queens Way, Waddon Factory Estate, Croydon

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TECHNICAL ASSISTANT (CHEMICAL)

The work is primarily concerned with the development of processes for chemical cleaning and electro-plating of metals.

It also includes the investigation of valve materials and processes connected with the manufacture of transmitting and microwave valves.

The possession of O.N.C. or equivalent qualification is essential and some previous experience in this field would be helpful.

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2 MUFFLE HANGING FURNACES. Incandescent Heat Co., Oil converted to gas fired. 14'6" × 5'7" deep × 2'10" wide overall. Complete with chargers, adjacent self-heated drying chambers, recording and controlling equipment.

MUFFLE FLAT FIRING FURNACE. Incandescent Heat Co. Gas fired. 7'6" × 3'6" wide × 2'9" deep overall. Complete with charger, recording and controlling equipment.

Apply: ENTWISLE & KENYON LTD.
ACCRINGTON, LANCS. Tel.: 32631

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FOR SALE—Two Canning Four Track In-Line Automatic Bright Nickel Plating Plants, including Rectifiers. Capacity 384 sq. ft./hour Each. Size 123ft. × 15ft. × 15ft. high. Jig Size 25in. × 25in. Plants already dismantled but not complete. Available as Units or in small Lots for Spares. Box No. FS 245 M.F.J.

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NICKEL PLATING SOLUTION

D303 (SULPHUR FREE)

- ★ Maximum Ductility
- ★ High Levelling Power
- ★ Excellent Corrosion Resistance
- ★ Low Internal Stress

SEE US ON STAND P.90
At the Factory Equipment Exhibition, Earls Court on 13th-19th November.

Improve the quality of your Nickel Plating by changing to D303, for a first grade undercoat.
For fully bright deposits, with ductility, high corrosion resistance, and low internal stress, follow D303, semi-bright nickel with the 101 fully bright nickel plating process.

Please write for further information to:—

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Phone: CENtral 8553 (6 lines) Grams: Cruickshank B'ham.

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Coloured Gel Coats for Reinforced Polyester Laminates

A NEW range of coloured Gel coats for reinforced polyester laminates has been introduced in 15 standardized colours by the Plastics Colour Division of Ferro Enamels Ltd., Wombourn, Wolverhampton. These new Gel coats, for which a colour matching service is available, free of charge, are intended for spray and brush application, which provide flexibility in operation and methods of economy in production (the coats are thinned to the desired viscosity with acetone for spraying).

With the Ferro Gel coats maximum pigment concentration gives full coverage of the mould with a thin application, and the overall cost per square foot is low. All the solids and resins are intimately mixed to minimize voids in the cured Gel coat, thus simplifying finishing operations.

In addition to the 15 standardized colours, special colours can be matched if required.

Meters for Severe Environments

A LINE of long-scale, three-inch edgewise d.c. and a.c. meters has been developed by the American associates of Honeywell Controls Ltd., Greenford, Middlesex for use in control console and equipment applications needing reliable indications in severe environments.

The instrument, hermetically sealed, is available in a broad selection of d.c. current (200 microamperes and up) and voltage ranges, as well as in rectifier-type a.c. stylus. The mechanism is shielded and the panel has no influence on calibration.

The instrument, known as MDE-3, may be mounted horizontally or vertically. Its case size (3.7 by 6.1 by 1.3 inches) makes it possible to mount the meters close together and to obtain in-line read-out.

Scratch-Test Machine

METAL Porcelains Ltd., Cornwall Road, Smethwick 40, offer a new machine which has been developed because no comparable existing machine or instrument would fulfil the function of testing and recording with precision the comparative scratch resistance properties or surface hardness of a wide range of vitreous and other enamels, glass, plastics, metal, coated surfaces, paint etc.

Now that domestic and industrial finishes are becoming increasingly important, the way a product will wear, travel and fulfil its function needs to be known.

Fig. 2 shows the machine in use in the laboratory of M.P.L. testing the scratch resistance of the porcelain enamel they manufacture.

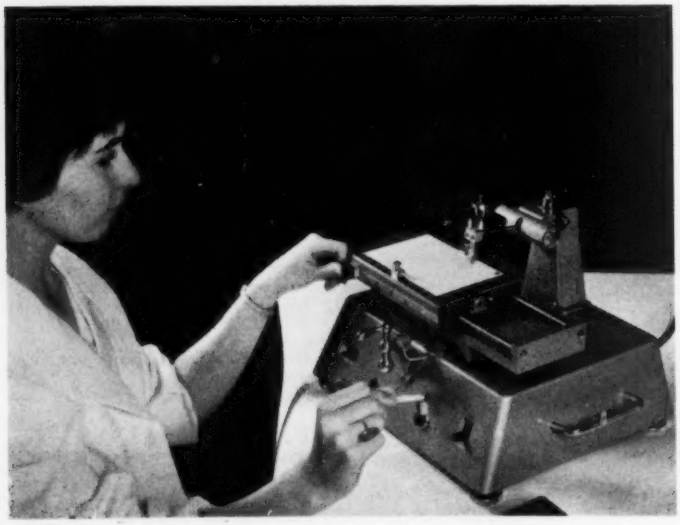

Fig. 2.—Scratch-test machine

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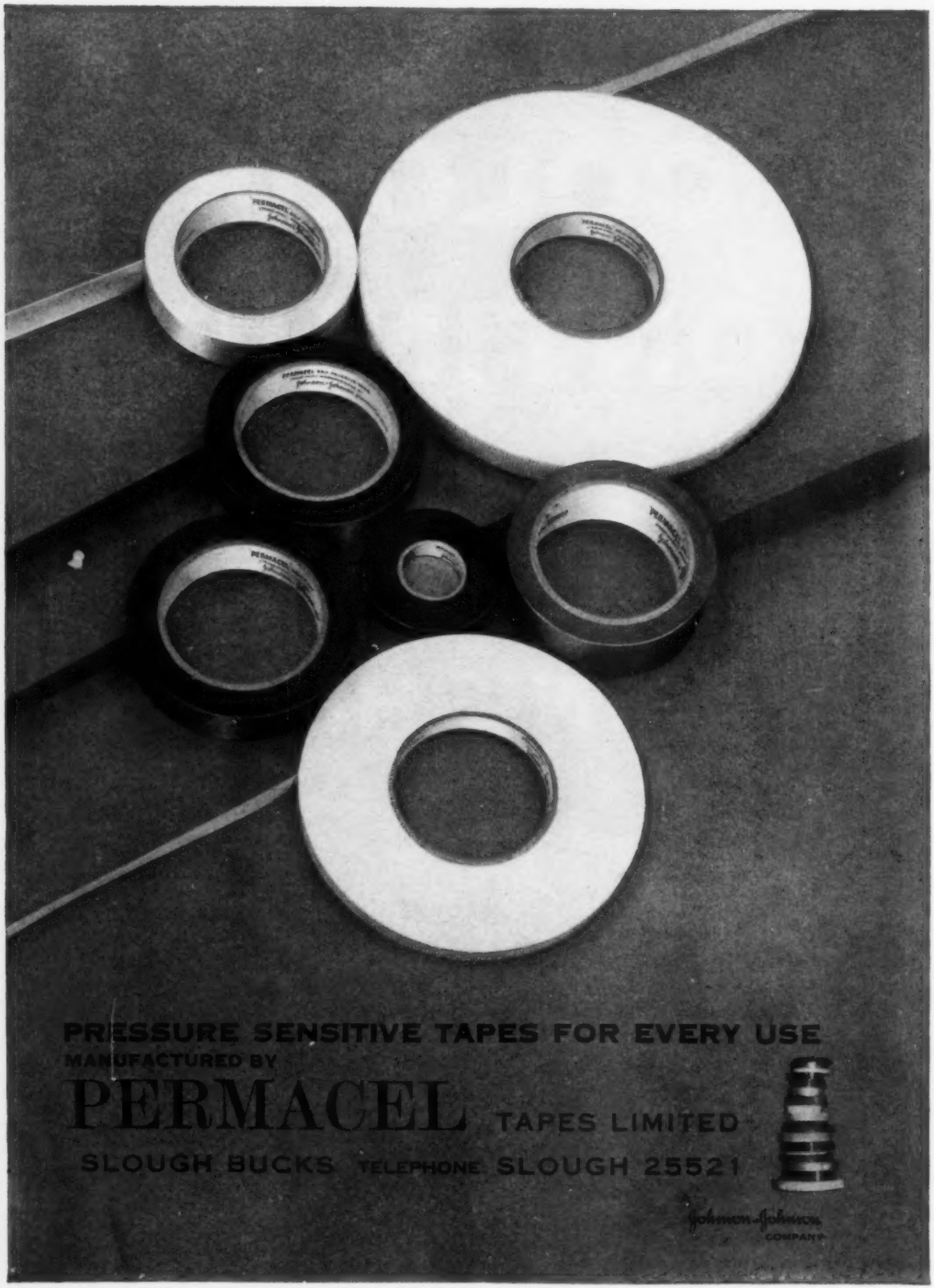
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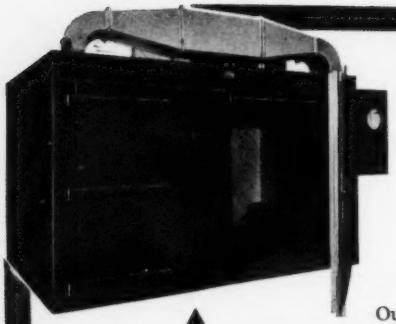

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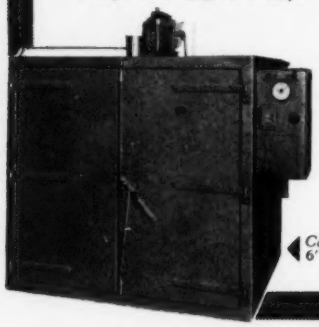

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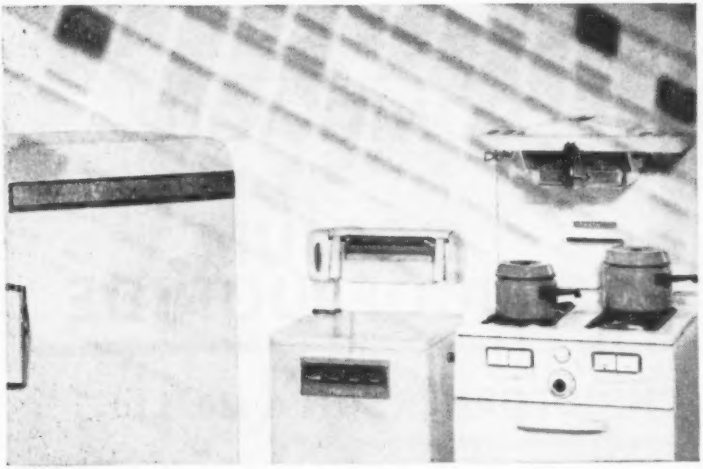

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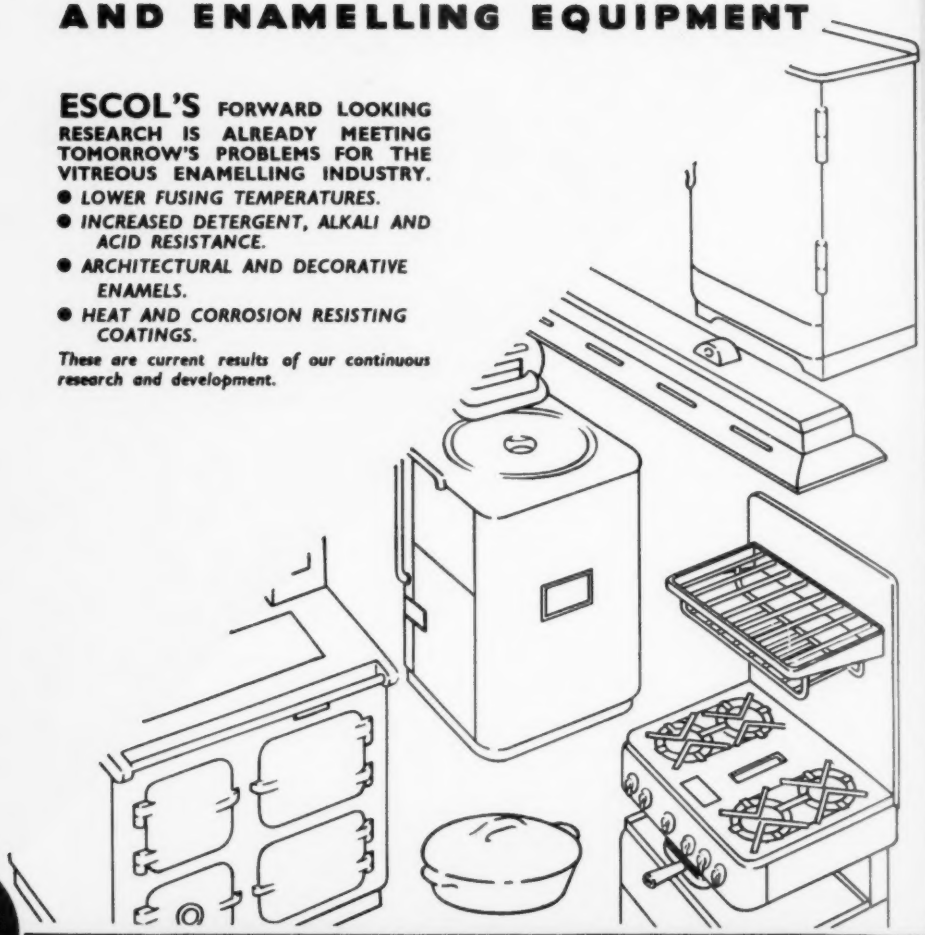

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